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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FALLOUT PREDICTION

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FOREWORD

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TECHNICAL MANUAL
No. 3-210

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *22 May 1962*

FALLOUT PREDICTION

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*This manual supersedes so much of TC 101-1, 9 December 1958, including C 2, 14, June 1960, as pertains to the prediction of fallout.

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CHAPTER 1

INTRODUCTION TO FALLOUT PREDICTION

1. Purpose

This manual provides guidance in the preparation of detailed and simplified fallout prediction to commanders at all echelons within the Army and provides procedural guidance for those persons operating in the chemical, biological, and radiological element (CBRE).

2. Scope

a. The material presented in this manual is applicable to nuclear warfare conditions.

b. Chapters 1 through 4 provide guidance in fallout prediction to commanders and staffs of all arms and services within the Army. Chapters 5 through 7 provide more detailed guidance for those personnel (primarily Chemical Corps) who are directly involved in the CBRE functions at major headquarters. Example problems of different portions of the fallout prediction are contained in appendix II and are referenced in the body of the manual. The figures and tables located in appendix III are referenced in the body of the manual or in appendix II as their purpose is established.

3. Need

a. The need for a fallout prediction stems from the large-area radiological contamination hazard that can develop from a surface (fallout-producing) burst. This large-area hazard is capable of producing mass casualties if its presence is not detected or if commanders at all echelons do not understand its effects. Thus fallout has a considerable impact on military planning and operations.

b. There are many occasions when a commander will require a fallout prediction to aid in evaluating the effect of fallout on the mission. Four occasions that will commonly occur are discussed below:

(1) When the commander plans the use of a nuclear weapon against a surface target, the uncertainties of the weapon fuzing system are such that the commander cannot insure that a fallout-producing burst will not occur. Thus a prestrike fallout prediction should be a part of each target analysis.

(2) When information indicates that fallout is occurring or that fallout will probably occur from a nuclear burst (friendly or enemy), a fallout prediction is required to enable the commander to warn higher, adjacent, and subordinate units.

(3) When a fallout-producing burst occurs, an evaluating procedure is initiated which will answer the commander's questions about the fallout hazard. However, a timelag of several hours to a day or more may occur between the time of burst and the availability of the hazard evaluation. During this timelag the fallout prediction, or at best the fallout prediction modified by measured data, is all that will be available for estimating the effects of the hazard on operations or plans. This timelag occurs because—

(*a*) Measured data cannot be obtained until fallout in an area of interest is complete. Militarily significant fallout in an area may not be complete for a period of several hours to a day or more after the time of burst, depending upon the yield, distance from ground zero, and wind structure. The obtaining of measured data may also be delayed by the difficulties of night survey or the operational situation.

(*b*) Several additional hours may be required for the reporting and processing of measured data into usable form.

(4) When information is needed to plan surveys or other aspects of the collection effort, the fallout prediction establishes an outline that can be used for this purpose.

4. Fallout Prediction Procedures

To satisfy command requirements at all echelons, two procedures for fallout prediction are established as explained below:

a. The primary procedure consists of a *detailed* method to be employed by the CBRE in preparing fallout predictions for use by major commands and subordinate units.

b. The supplemental procedure consists of a *simplified* method that can be used by any unit. The simplified method employs a "Simplified Fallout

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Predictor." In a nuclear war, it may be expected that small, mobile units will be operating in widely dispersed areas. In such situations, receipt of fallout predictions from major command headquarters may be delayed for significant periods of time. The supplemental procedure provides small units with an immediate capability of fallout prediction, thereby allowing greater unit self-sufficiency.

5. Significance of Predicted Fallout Zones

a. Inside the Predicted Area. In both simplified prediction and detailed prediction, the predicted zones define those areas within which exposed, unprotected personnel *may* receive militarily significant total doses of nuclear radiation in the first several hours *after* actual arrival of fallout. A primary zone of hazard and a secondary zone of hazard are predicted.

(1) Zone I delineates the area of primary hazard and is called the *Zone of Immediate Operational Concern.* It is defined as a zone within which there will be areas where exposed, unprotected personnel may receive casualty-producing doses (greater than 100 rad) in relatively short periods of time (less than 4 hours after actual arrival of fallout). Major disruption of unit operations and casualties among personnel may occur within portions of this zone. The actual areas of major disruption are expected to be smaller than the entire area of Zone I; however, the exact locations cannot be predicted. If personnel within this zone have previously been exposed to nuclear radiation, the effects of the fallout may be even more pronounced.

(2) Zone II delineates an area of secondary hazard and is called the *Zone of Moderate Risk.* It is defined as a zone within which exposed, unprotected personnel are *not* expected to receive a total dose of more than 100 rad when remaining in the area for not more than 4 hours *after* actual arrival of fallout. However, only a small percentage of *exposed* troops in the Zone of Moderate Risk are expected to receive this dose. Personnel with no previous significant radiation exposure may be permitted to continue critical missions for as much as 4 hours *after* actual arrival of the fallout without incurring casualty-producing doses. However, if personnel in this zone have received previous significant radiation doses, serious disruption of unit mission and casualty-producing doses may be expected.

b. Outside the Predicted Area. Outside Zones I and II, it is anticipated that exposed, unprotected personnel will receive a total dose that does not exceed 20 rad in the first 6 hours *after* actual arrival of fallout. The total dose for an infinite time of stay *outside* Zones I and II should not exceed 150 rad. Therefore, outside these zones, no serious disruption of military operations is predicted to occur if personnel have not previously been exposed to nuclear radiation. Appreciable previous exposure should be considered. In either case, routine radiological defense measures, including periodic monitoring, will normally provide adequate protection.

c. Reliability. The predicted zones of fallout are larger than the actual area of the ground that will be covered by this fallout. These zones represent areas of hazard, somewhere within which fallout is predicted to be found. Because of uncertainties of weather and nuclear burst input data, the precise locations of fallout within the zones cannot be reliably predicted, but must be ascertained by monitoring and survey after fallout has settled. The two zones have, therefore, been developed so that there is a reasonably high assurance that the expected fallout will not occur outside them. They represent an expected hazard area that can be quickly predicted immediately after nuclear burst information is obtained.

d. Interpretation. The lines enclosing Zones I and II are not to be construed as absolute boundaries for the occurrence of fallout. It is emphasized that as these predicted zones are approached from the outside, the likelihood of encountering hazardous fallout will increase and the dose rates encountered will gradually increase.

6. Basic Data

a. Requirement. The final location of fallout is primarily dependent on, first, the heights from which the fallout particles start their downward descent; and, second, the wind structure between the ground and various portions of the cloud during the period of fall of these particles. The initial heights of the fallout particles are determined by the total yield of the nuclear burst. Thus, the reliability of a fallout prediction depends to a great extent on the upper air wind data and nuclear burst information available.

b. Nuclear Burst Information.

(1) *Essential.* The nuclear burst information

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required for the preparation of any fallout prediction is—

(*a*) Location of ground zero (GZ).

(*b*) Total yield (assume yield to be all fission except for the special cases in (2) below) or nuclear burst and cloud parameters for computation of yield.

(*c*) Time of burst (not essential for prestrike predictions).

(*d*) Type of burst (when a fallout-producing burst is indicated, assume surface burst except for the special cases in (2) below).

(2) *Special.* Height of burst (HOB) and fission yield/total yield (FY/TY) ratio information may be used for detailed prestrike fallout predictions prepared for friendly nuclear burst from which fallout is expected. For detailed poststrike predictions of friendly nuclear bursts that inadvertently produce fallout, only the FY/TY ratio may be used.

c. Sources. Nuclear burst information may be obtained from the command that directed the firing of a nuclear weapon, from nuclear burst report data, or from intelligence estimates; or may be assumed for troop safety. A fallout prediction will normally be prepared on the basis of the situations indicated below:

(1) Prestrike fallout predictions for enemy nuclear bursts, which are prepared as parts of vulnerability studies, are based on assumed nuclear burst information. Intelligence estimates of enemy capabilities and observations of enemy weapons previously used in similar situations may be used to support these assumptions.

(2) Prestrike fallout predictions prepared as part of a target analysis for nuclear bursts that are not intended to produce fallout are based on planned nuclear burst information, except that the burst is assumed to be a surface burst for troop safety.

(3) Prestrike fallout predictions prepared as part of the target analysis for nuclear bursts from which fallout is intended will be based on planned information. HOB and FY/TY adjustments may be used if a detailed fallout prediction is prepared.

(4) Postburst information may indicate that fallout will probably occur or that fallout has started from a nuclear burst. Poststrike fallout predictions for friendly bursts from which fallout was not originally expected are prepared on the basis of an assumed surface burst, using planned yield, FY/TY ratio, and ground zero. Actual ground zero will be used in this case if nuclear burst report data are available. Poststrike fallout predictions for enemy bursts are prepared on the basis of information derived from nuclear burst report data. A surface burst is assumed in this case for troop safety.

d. Upper Air Wind Data. Upper air wind data to be used in the prediction of fallout may be obtained in the field army from the U.S. Army artillery meteorological sections; the U.S. Air Force Air Weather Service (AWS) detachments that support the field army may be used to augment these data. Upper air wind data may be obtained from sources other than artillery and AWS. Guidance is provided in chapter 5 for using upper air wind data from the U.S. Army artillery, Air Weather Service U.S. Weather Bureau, or other weather services.

7. Training

a. Individual Training. Unit commanders will insure that selected individuals are trained in the construction and use of the simplified fallout predictor and in the preparation of the fallout prediction plot from the fallout prediction message. In addition, all individuals will be trained to such a level that they will have a basic understanding of fallout hazards and protective measures. Service schools will train selected personnel in techniques of determining effective wind speed and direction and in preparing detailed fallout predictions.

b. Unit Training. Fallout situations will be integrated into unit training exercises. Standing operating procedures will contain adequate instructions on actions to be taken when units are alerted to expected contamination (based on the fallout prediction). Provisions will be made for the use of fallout prediction in tactical planning.

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CHAPTER 2

DETAILED FALLOUT PREDICTION

8. Description

a. The detailed fallout prediction is prepared at the CBRE. It is based upon nuclear burst information and upper air wind data (par. 6). The upper air wind data are rapidly processed into a fallout wind vector plot each time new upper air wind data are received. With a current wind vector plot, the CBRE can have a detailed fallout prediction ready for dissemination in a matter of minutes after required nuclear burst information is available.

b. The completed prediction consists of two zones of hazard. The significance of the two zones has been described in paragraph 5. The detailed prediction is illustrated in figure 1 and is delineated by the following:

(1) Identification of grid north (GN), map scale, GZ coordinates, and time of burst.

(2) Two radial lines, drawn from the ground zero point at azimuths determined from the wind vector plot.

(3) Two downwind arcs, representing the downwind distance of Zone I and Zone II.

(4) A circle drawn around GZ with a radius equal to the stabilized cloud radius.

(5) Two tangents drawn from the ground zero circle to the points of intersection of the two radial lines with the arc representing the downwind distance of Zone I.

(6) One or more time-of-arrival arcs, representing the time of arrival of fallout as it moves downwind from ground zero.

c. Procedures employed in the CBRE in the preparation of the detailed prediction are presented in chapter 6.

d. A sufficient number of overlay copies of the detailed fallout prediction plot will be prepared by the CBRE for use within the tactical operations complex. The detailed fallout prediction is disseminated to staff agencies outside the tactical operations complex, and to higher, adjacent, and subordinate units in message form (par. 9).

9. Fallout Prediction Message

a. The detailed fallout prediction is disseminated from the CBRE in the form of a prediction message. The format for the message will be a series of lines, preceded by the phrase "Fallout Prediction Message," as follows:

Fallout Prediction Message

ZULU	DDtttt
FOXTROT	yyzzzzzz
GOLF	dddccc
HOTEL	ssxxxrr

b. The significance of each line is as indicated below:

(1) ZULU DDtttt—This line is the date-time group of the burst, with DD the day and tttt H-hour in Greenwich Civil Time (GCT).

(2) FOXTROT yyzzzzzz—This line provides the coordinates of ground zero, with yy the two letters representing the appropriate 100,000-meter grid square and zzzzzz the coordinates of ground zero within this grid square.

(3) GOLF dddccc—This line provides the azimuths of the two radial lines to the nearest degree from grid north, with ddd the azimuth of the left radial line and ccc the azimuth of the right radial line. Left and right in this case are as for an observer at ground zero looking downwind at the prediction.

(4) HOTEL ssxxxrr—This line provides prediction dimensions, with ss the effective wind speed to the nearest kilometer per hour (km/hr), xxx the downwind distance of Zone I to the nearest kilometer (km), and rr the radius of the stabilized cloud (GZ circle) to the nearest kilometer.

10. Use of Fallout Prediction Message

a. Prediction Plot. Upon receipt of a fallout prediction message, the recipient will prepare a fallout prediction plot on a piece of overlay paper or other transparent material by using the following procedures:

(1) Identify the prediction by marking and labeling some point as GZ, drawing and labeling a grid north line, writing in map scale and date-time of burst (ZULU DDtttt), and referencing the overlay with

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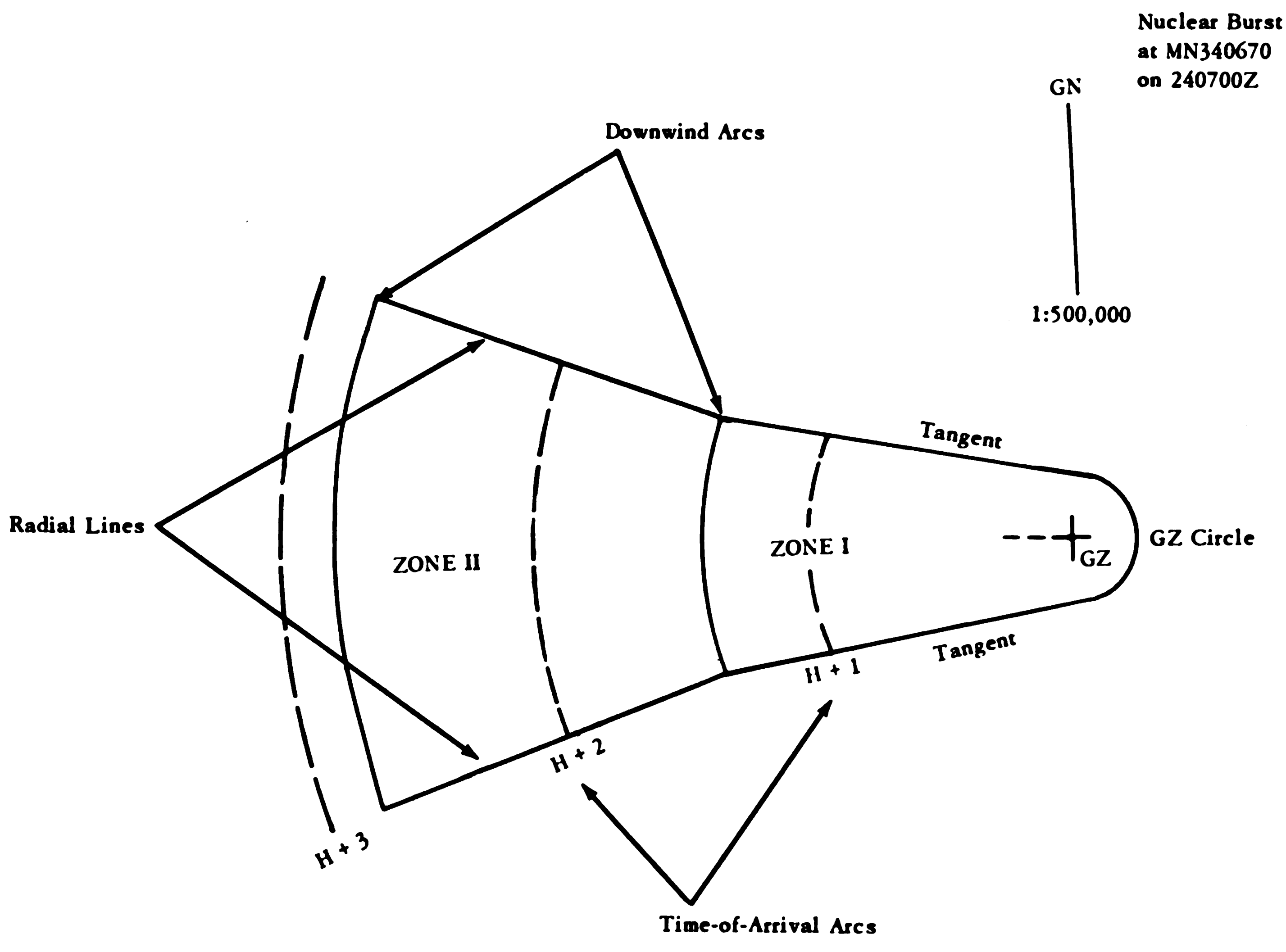


Figure 1. Detailed fallout prediction (designation of parts).

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GZ coordinates or index points (FOXTROT yyzzzzzz).

(2) From the ground zero point, draw the left (GOLF ddd) and right (GOLF ccc) radial lines at the proper azimuths from the grid north line.

(3) Draw an arc between the two radial lines with a radius equal to the downwind distance of Zone I (HOTEL xxx). Draw a second arc between the radial lines at twice this radius for the downwind distance of Zone II.

(4) Draw a circle around ground zero with a radius equal to the radius of the stabilized cloud (HOTEL rr).

(5) Draw tangents from the ground zero circle to the points of intersection of the radial lines with the arc representing the downwind distance of Zone I.

(6) Draw as many dashed time-of-arrival arcs between the radial lines or tangent lines as are required for the user's purposes. Label each time-of-arrival arc as hours after H-hour. Times of arrival are estimated by using the effective wind speed (HOTEL ss) as indicated in *b* below.

b. Times of Arrival.

(1) Times of arrival of fallout can be estimated by multiplying the effective wind speed by the hour of interest. Time of arrival of fallout at a specific distance from ground zero can be *estimated* by dividing that distance by the effective wind speed.

$$\text{Time of arrival (hr)} = \frac{\text{distance from GZ (km)}}{\text{effective wind speed (km/hr)}}$$

However, this procedure is not valid for times of arrival of less than H+½ hour.

(2) For operational purposes, the following rules of thumb may be applied to the actual arrival of fallout:

(*a*) The actual arrival of fallout may occur as early as one-half the estimated time of arrival. That is, if estimated time of arrival of fallout is H+4 hours, actual arrival of fallout may occur as early as H+2 hours.

(*b*) If actual arrival of fallout has not occurred at twice the estimated arrival time, or 12 hours, whichever is earlier, then it may be assumed that the area will not receive fallout. That is, if the estimated time of arrival of fallout in an area is H+4 hours and fallout has not occurred at H+8 hours, then it may be assumed that the area will not receive fallout.

c. Orientation. With the fallout prediction overlay completed and times of arrival of interest included, the overlay can be oriented on the operations map and the operational impact can be estimated.

d. Example. Example problem 1, appendix II, illustrates the preparation of a detailed fallout prediction from the fallout prediction message.

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CHAPTER 3

SIMPLIFIED FALLOUT PREDICTION

11. Description

a. The simplified fallout prediction method is provided to enable small unit commanders to make an *immediate* estimate of the location of the potential fallout hazard without waiting for a detailed fallout prediction message from the CBRE's of major commands.

b. The simplified prediction method requires nuclear burst information (par. 6*b*), a current effective wind message (par. 12), and a simplified fallout predictor (par. 13.)

c. The lateral or angular limits of the simplified fallout predictor are fixed at 40 degrees; this is in contrast to the determination of lateral limits from current winds in the detailed method. These fixed angular limits are based upon climatological studies. Thus, the simplified method provides the small unit commander with an "order of magnitude" estimate of the lateral limits of the area of hazard. However, both the simplified prediction method and the detailed prediction method use the effective wind speed in the same manner. Therefore, both methods present the same degree of accuracy in downwind distance.

12. Effective Wind Message

a. Use of the simplified fallout predictor requires knowledge of the effective wind speed and direction. This information is prepared by the CBRE as an effective wind message and is transmitted down to company level each time new upper air wind data are received. Since the effective wind speeds and directions vary with yield, five wind speeds and directions are transmitted, corresponding to the five preselected yield groups. Effective wind messages more than 12 hours old should be used with caution for fallout prediction.

b. The format for the effective wind message will be a series of six lines, preceded by the phrase "Effective Wind Message," as follows:

Effective Wind Message

ZULU	DDtttt
ALFA	dddss
BRAVO	dddss
CHARLIE	dddss
DELTA	dddss
ECHO	dddss

c. The significance of each line is as indicated below:

(1) ZULU DDtttt—This line is the date-time group (GCT) at which the winds were measured, with DD the day and tttt the hour.

(2) The remainder of the lines provide data for the five preselected yield groups, where ddd is the effective wind direction in degrees from grid north and ss is the effective wind speed to the nearest kilometer per hour.

(*a*) ALFA dddss is the data line for the 2-kiloton (KT) or less yield group.

(*b*) BRAVO dddss is the data line for the more than 2-KT through 5-KT yield group.

(*c*) CHARLIE dddss is the data line for the more than 5–KT through 30–KT yield group.

(*d*) DELTA dddss is the data line for the more than 30–KT through 100–KT yield group.

(*e*) ECHO dddss is the data line for the more than 100–KT through 300–KT yield group.

(3) For example, if the DELTA line of an effective wind message read DELTA 09025, the person using this information would know that the DELTA line is used when the yield of the weapon is in the range from more than 30 KT through 100 KT. The contents of this DELTA line would indicate that the fallout prediction would be determined from an effective wind speed of 25 kilometers per hour and an effective wind direction of 90 degrees.

13. Simplified Fallout Predictor

The fallout predictor (fig. 2) is a transparent device used to outline the two zones of hazard for five preselected yield groups. The simplified fallout predictor consists of four major parts:

a. An azimuth dial for orientation.

b. Semicircles depicting stabilized nuclear cloud radii drawn about ground zero and showing the area of contamination for each of the five preselected yield groups.

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c. A map scale calibrated in kilometers along two radial lines extending out from ground zero.

d. A nomogram (fig. 3) for determining the downwind distances of Zones I and II. The nomogram is not required for field constructed predictors (par. 15). The nomogram has five lettered scales:

(1) Scale (a) is the mil width of the nuclear burst cloud used for yield estimation.

(2) Scale (b) has two indexes; the right index is flash-to-bang time measured in seconds and used for yield estimation; the left index is the distance in kilometers from ground zero to the observer, corresponding to the measured flash-to-bang time. The distance is used to locate ground zero.

(3) Scale (c) is the yield in KT.

(4) Scale (d) is the downwind distance of Zone I in kilometers.

(5) Scale (e) is the effective wind speed in kilometers per hour as determined from the effective wind message.

14. Procedures for use of Simplified Method

a. Information Required. Use of the simplified fallout predictor requires a current effective wind message and the nuclear burst information in paragraph 6*b*. Scales (a), (b), and (c) of the nomogram on the simplified fallout predictor provide a means of determining location of ground zero and an estimate of the total yield. Normally, the user of the simplified predictor will have to estimate the required nuclear burst information from nuclear burst reports or from nuclear burst report data.

b. Identification of the Prediction. Identification of the prediction is accomplished by recording on the predictor the location of ground zero and time of burst.

c. Effective Wind Speed and Direction. The effective wind speed and direction for the burst are taken from the appropriate yield group data line of the effective wind message (par. 12).

d. Downwind Distances of Zones I and II. The downwind distance of the Zone of Immediate Operational Concern (Zone I) is determined from the nomogram from the simplified fallout predictor (fig. 3). This determination is made by connecting the value of the effective wind speed on scale (e) with a straightedge to a point on the index line of scale (c) representing the yield (the actual yield is used in this case, not the yield group). The value of the downwind distance of Zone I, in kilometers, is read at the point of intersection of the straightedge and the scale (d). The downwind distance of Zone II is twice that of Zone I. Arcs are then drawn between the two radial lines, using GZ as center with radii equal to the two downwind distances determined.

e. Tangents. Tangents are now drawn from the cloud radius line for the yield group (*c* above) to the points of intersection of the radial lines of the predictor with the arc representing the downwind distance of Zone I (*d* above).

f. Perimeter. Zones I and II are now labeled and the remainder of the prediction perimeter is drawn in; that is, the radial lines between the two downwind arcs of *d* above and the cloud radius line of *e* above.

g. Time-of-Arrival Arcs. Time-of-arrival arcs of interest are now drawn in, using the effective wind speed and the procedure in paragraph 10*b*.

h. Orientation. Next, place the fallout predictor ground zero point over the actual or assumed GZ on the map, and rotate the entire fallout predictor until the effective wind direction in degrees on the azimuth dial is pointing toward grid north.

i. Evaluation. The simplified fallout prediction is now complete, and the operational aspects of the fallout hazard can be evaluated.

j. Special Case. A special case may arise when one or more of the data lines of an effective wind message may contain only two digits. In this case, the two digits will be the radius of Zone I and the fallout prediction will be made as described in paragraph 17.

k. Example. Example problem 2, appendix II, illustrates the use of a simplified fallout predictor in the preparation of a simplified fallout prediction.

15. Field Construction of Simplified Fallout Predictor

a. If the fallout predictor shown in figure 2 is not available, a predictor can be constructed from any pliable, transparent material, and to any desired map scale, by the following procedure:

(1) *Step 1.* On a piece of pliable, transparent material, draw a thin dotted line (reference line) to a scaled length of 30 kilometers from a point selected to represent ground zero (1, fig. 4).

(2) *Step 2.* Draw two radial lines from ground zero at angles of 20 degrees to the left and to the right of the dotted reference line (2, fig. 4).

(3) *Step 3.* On the side of ground zero opposite the reference line, draw a series of concentric semicircles (using the selected map scale) having radii of 1.2 kilometers, 1.7

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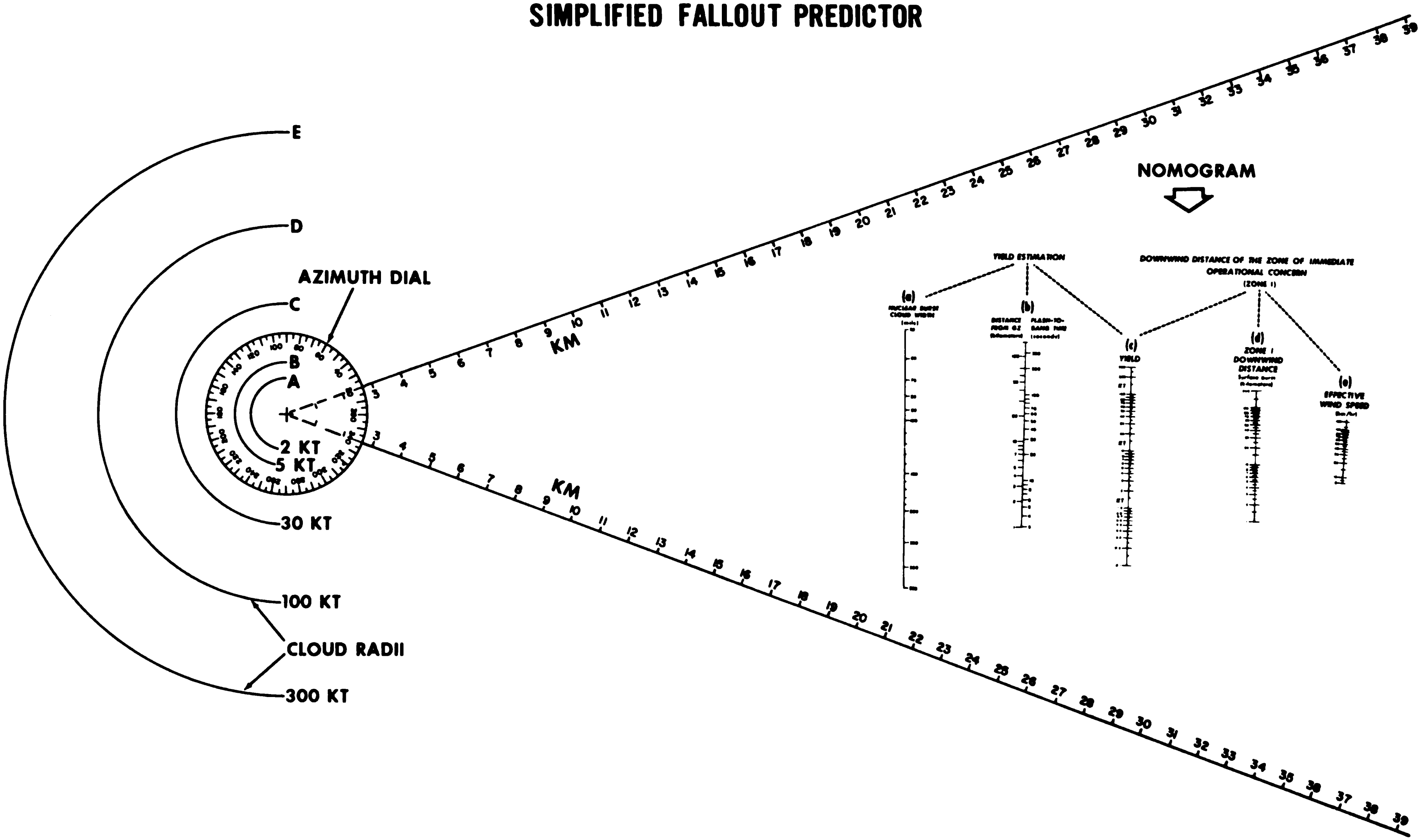


Figure 2. Simplified fallout predictor.

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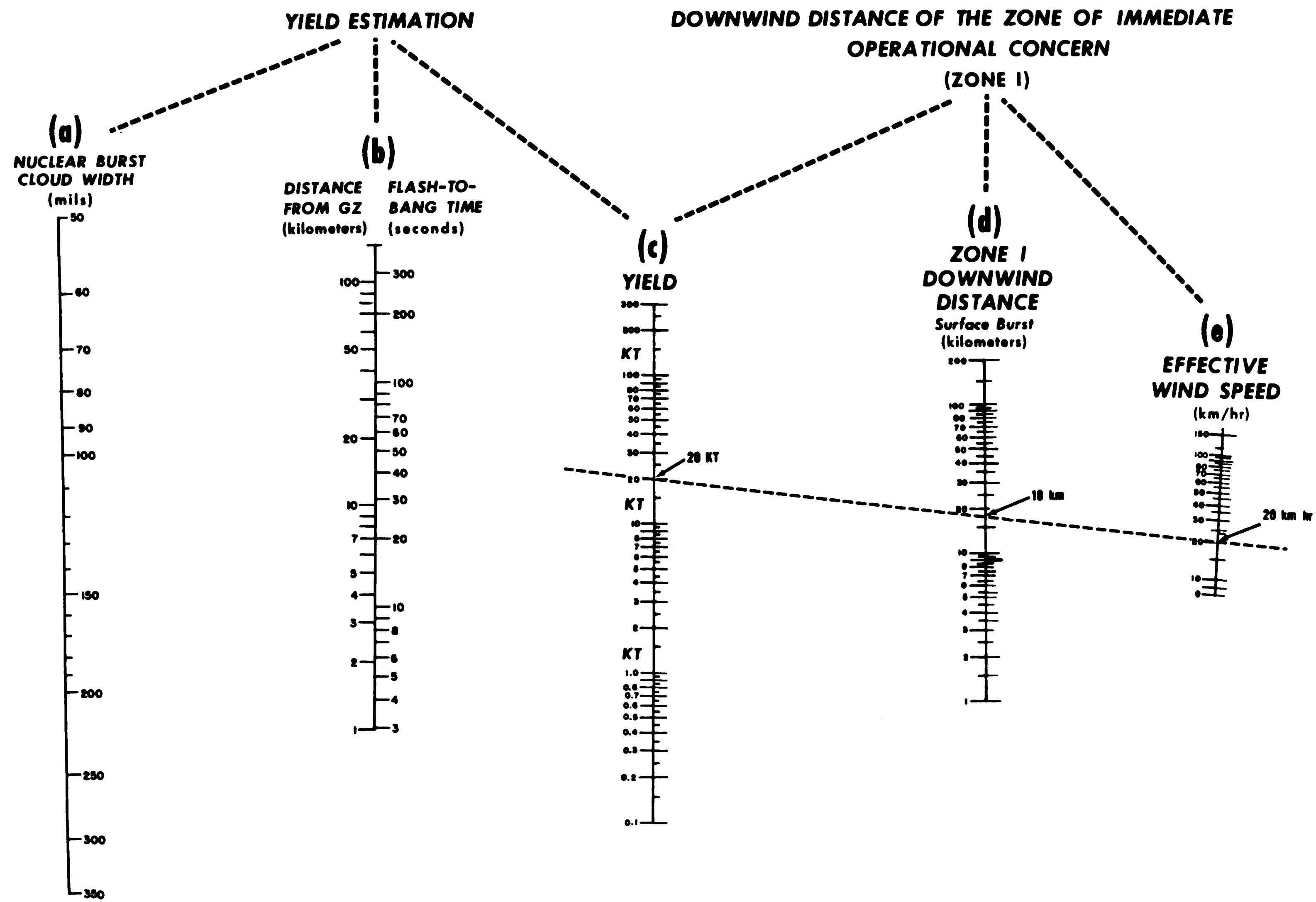


Figure 3. Zone I downwind distance nomogram.

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kilometers, 3.6 kilometers, 6.0 kilometers, and 9.3 kilometers, which correspond to stabilized cloud radii from nuclear bursts with yields of 2 KT, 5 KT, 30 KT, 100 KT, and 300 KT, respectively (3, fig. 4).

(4) *Step 4.* Label the semicircles constructed in step 3. Starting with the line closest to GZ and moving up from GZ, label the lines A, B, C, D, and E; moving down from GZ, label the lines 2 KT, 5 KT, 30 KT, 100 KT, and 300 KT, respectively (3, fig. 4).

(5) *Step 5.* Using the selected map scale, graduate the reference line and the two radial lines in kilometers (3, fig. 4).

b. To use the field-constructed fallout predictor, determine the downwind distance of the Zone of Immediate Operational Concern from figure 18 and complete the simplified fallout prediction, using the procedures established in paragraph 14. The resulting prediction is then oriented by placing a protractor over an actual or assumed GZ on the map and drawing a line to represent the effective wind direction for the yield group of interest. Place ground zero of the predictor over ground zero on the map and rotate the predictor until its reference line coincides with the effective wind direction.

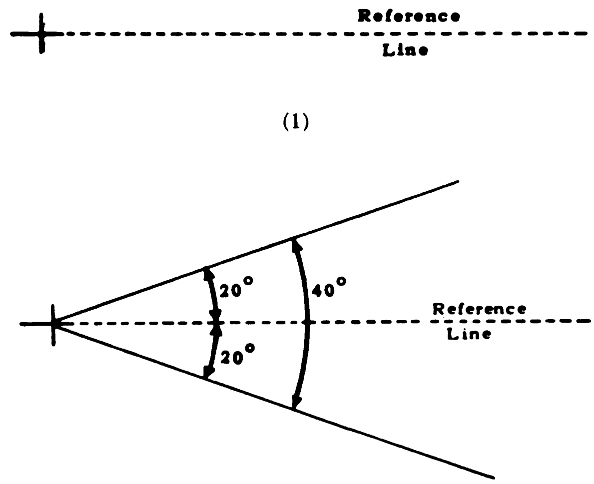


Figure 4. (2) *Construction of simplified fallout predictor.*

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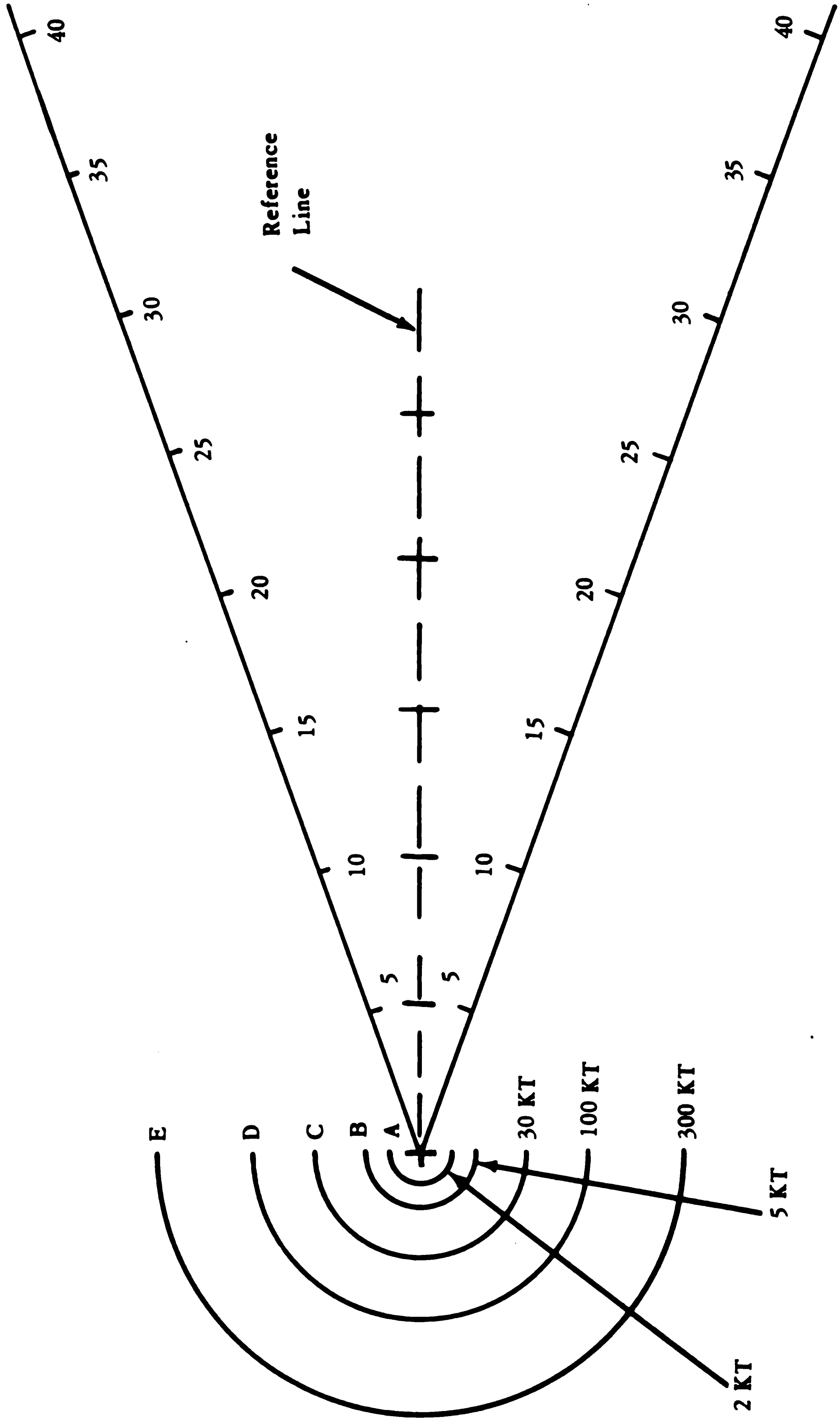


Figure 4 (3)—Continued

CHAPTER 4

SPECIAL FALLOUT PREDICTION CASES

16. Overlapping Contamination

It is probable under nuclear warfare conditions that there will be occasions when a fallout prediction will overlap an area in which contamination already exists. Similarly, there will be cases when fallout predictions will overlap each other; for example, two fallout-producing bursts occurring within a few hours of each other where one was upwind from the other. In all such overlap areas, indicate the hazard zones by normal procedures, realizing that overlap areas have a high probability of receiving a greater risk than predicted.

17. Very Low Winds

The situation may arise when the effective wind speed cannot be reliably defined for a particular burst. This results when the effective wind speed is less than 8 kilometers per hour. In this case, fallout may occur at almost any location around ground zero, and the predicted area of hazard will be a circle around ground zero. To prepare a fallout prediction in these instances, determine the downwind distance of Zone I, using the appropriate yield and an effective wind speed of 8 kilometers per hour. A circle of this radius drawn around ground zero will define Zone I. A second circle of twice this radius will define Zone II. Time of arrival will have no meaning in this case and will not be represented on the prediction plot. Detailed and simplified prediction methods are the same in this special case.

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CHAPTER 5

FALLOUT WIND VECTOR PLOT

18. Significance of the Fallout Wind Vector Plot

The fallout wind vector plot is prepared by the CBRE on receipt of new upper air wind data. The plot is prepared on overlay paper, oriented to grid north, and drawn to a convenient scale. It consists of a series of vectors representing wind layers between the surface of the earth and the height to which upper air wind data are obtained. The vectors are plotted head to tail, and each vector represents the distance and direction a nominal size particle would travel over the earth while falling through the wind layer. The nominal size particle is defined to be of such a size as to require 3 hours to fall from 11,000 meters to the ground. The significance of the wind vector plot is that after it is oriented by the GZ tickmark and grid north, it represents a series of points on the ground where the nominal size particles (143 microns) are expected to land. That is, a nominal size particle starting at 30,000 meters is expected to land on the ground at the point represented by 30,000 meters on the wind vector plot. Similarly, a nominal size particle starting at 29,000 meters is expected to land on the ground at a point halfway between 28,000 meters and 30,000 meters on the wind vector plot. Further, a line drawn from GZ through a particular height point on the wind vector plot represents the locus of points on which all fallout particles from that particular height are expected to land. Heavier particles will land closer to ground zero than will the lighter ones, but all the particles starting from that particular height are expected to land along this line. The wind vector plot is used to determine the lateral limits of fallout, is available at the CBRE, and is ready for use when a fallout-producing nuclear burst occurs. A completed fallout wind vector plot for a particular set of upper air wind data is shown in 4, figure 11.

19. Upper Air Wind Data

a. Upper air wind data for fallout prediction by tactical units are normally obtained from division or corps artillery meteorological sections. The meteorological sections forward meteorological information to fire support coordination centers/fire support elements (FSCC's/FSE's), using the procedures and format established by FM 6–15 and summarized in *b* below.

b. The network of artillery meteorological sections in the corps sector provides all FSCC's/FSE's within the corps with the upper air wind data in (2) below to the heights and on the schedules indicated:

- (1) Heights and schedules are:
  - (*a*) To 30,000 meters or to the bursting height of the balloon, whichever comes first, four times daily at 0600, 1200, 1800, and 2400 hours GCT. Minimum acceptable height is 24,000 meters.
  - (*b*) To 20,000 meters eight times daily at 0200, 0400, 0800, 1000, 1400, 1600, 2000, and 2200 hours GCT. Minimum acceptable height is 16,000 meters.
- (2) Data provided are:
  - (*a*) Average wind speed in knots for each 2,000-meter layer above the mean datum plane (see AR 320–5) of the reporting meteorological section.
  - (*b*) Wind direction to the nearest 10 mils from which the winds in (*a*) above are blowing.

Note. Special data at significant levels (pressures, temperatures, and relative humidities) will be furnished only when specifically requested. A significant level is defined as being any level in the atmosphere where a significant weather change occurs.

c. The data listed above are transmitted by means of the corps field artillery meteorological net to the corps FSCC/FSE. Division and Army FSCC's/FSE's monitor this net to obtain data directly. The FSCC/FSE decodes and relays the upper air wind data to the CBRE.

d. Upper air wind data for fallout prediction where U.S. Army artillery wind observations are not available may be obtained from other sources. These upper air wind data must provide wind speeds and directions for consecutive wind layers above the observing station or altitude layers above mean sea level. For example, wind direction to the nearest 10 degrees from true north and wind speed to the nearest knot may be obtained from Air Weather Service (AWS) detachments with major commands in the field army. The primary source for upper air wind data in the continental United States is the U.S. Weather Bureau, which reports wind direction to the nearest 10 degrees and wind speed to the

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nearest knot. Wind direction is the direction *from which* the wind is blowing. Upper air wind observations are transmitted over various Federal Aviation Agency (FAA) and military weather communications circuits in a standard upper air wind code agreed upon internationally through the World Meteorological Organization. Decoding procedure is given in chapter 15, TM 1–300. If current wind data are not given to the required height, then the latest available data from previous reports for the higher levels are used to extend the plot. Up-to-date wind data that have been obtained from a source as close as possible to the actual or expected ground zero should be used.

e. U.S. Army artillery upper air wind data are preferable to wind data from other sources when the artillery data are obtained from an observation point not more than one and one-half times as far from the actual or expected ground zero as the data from other sources are from ground zero. Data from other sources, which report wind direction, speed, and height in units other than mils, knots, and kilometers, may be converted by using tables I and II (app. III).

20. Preparation of Fallout Wind Vector Plot

a. In preparing the fallout wind vector plot, successive vectors for each wind layer are laid off from the downwind end of the preceding vector, starting with the lowest height level and working upward. The direction of each vector is the same as the wind direction for that layer; the length of the vector is the product of the wind speed and a weighting factor. The weighting factor represents the time a nominal size fallout particle will spend in the layer multiplied by the appropriate distance conversion factor so that the vector length is in kilometers. The end of each vector is labeled with the height of the top of the layer it represents, and other identifying data are added (par. 24).

b. Tables and figures containing wind weighting and time-in-layer data are contained in appendix III.

c. Example problem 3, appendix II, illustrates the preparation of a fallout wind vector plot from U.S. Army artillery upper air wind data.

21. Wind Vector Plotting Scale

a. As illustrated in example problem 3, appendix II, several steps are involved in plotting each wind vector. This plotting is facilitated by the use of a plotting scale to reduce the number of steps involved. Some of the operations that are eliminated are the conversion of the direction *from* which the winds are blowing to the direction *toward* which the winds are blowing and the calculation of the vector length. The wind vector plotting scale (fallout prediction plotting scale ML–556/UM) illustrated in figure 5 permits plotting the wind vectors directly from artillery or Air Weather Service upper air wind data. The plotting scale is constructed of clear plastic and consists of two main parts:

(1) A compass rose with an inner scale in degrees and an outer scale in hundreds of mils.

(2) A series of 11 slots representing various wind layers (altitude zones) with wind speeds graduated in knots along each slot for use with 3 different map scales.

b. Plotting artillery upper air wind data with the plotting scale is accomplished as follows:

(1) Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with parallel lines that can serve as north-south grid lines. Mark GZ, scale, and grid north on the overlay paper.

(2) Lay the plotting scale on the chart so that the hole at the end of the slot labeled "0–2" lies over the starting point (GZ).

(3) Secure the scale to the chart by inserting a sharpened instrument (hard lead pencil or a pin) through the hole, and rotate the scale so that the line on the compass rose representing the wind direction for the lowest wind layer (0- to 2,000-meter) is parallel to the north-south grid lines and is oriented with the outer end pointing north. Note that the wind direction in this case is the wind direction as read directly from the artillery upper air wind data.

(4) Holding the scale firmly and using the "0–2" slot, draw a line to the point which represents the wind speed for the 0- to 2,000-meter layer. This point will be determined by using the map scale selected (indicated by the color legend from the plotting scale).

(5) Next, move the scale so that the hole at the end of the slot labeled "2–4" lies over the outer end of the wind vector just plotted. Orient the scale in the manner described in (3) above; however, this time use the wind direction for the 2,000- to 4,000-meter layer. Using the "2–4" slot, draw a line to the point representing the wind speed in the 2,000- to 4,000-meter layer.

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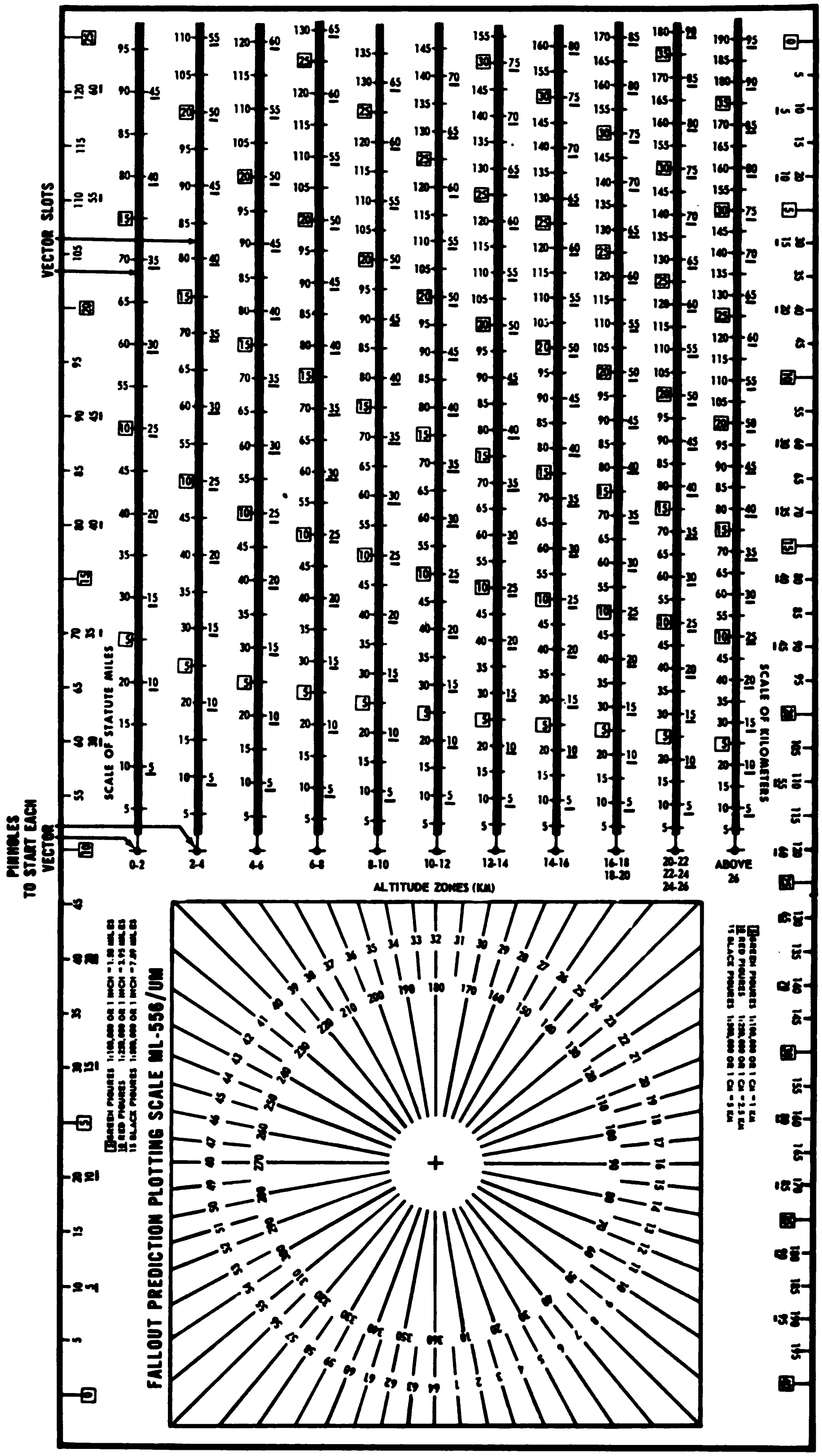


Figure 5. Wind vector plotting scale.

(6) Repeat this procedure for each wind layer until the plot is completed. Be sure to use the appropriate slot for each wind layer being plotted. Note that starting with the "16–18" slot, each slot is used to plot several vectors.

(7) Label the outer end of each wind vector with the height of the top of the layer it represents; for example, the first segment is labeled "2" and the second "4."

(8) See example problem 4, appendix II, which describes the preparation of a wind vector plot by use of the plotting scale with US Army artillery upper air wind data.

c. Plotting AWS upper air wind data with the plotting scale is accomplished in much the same manner as for artillery wind data, except that different slots are used for the wind layers; for heights above 45,000 feet, the vector is drawn to a point on the slot scale equal to one-half of the reported wind speed. Table IV (app. III) provides weighting factors and plotting scale data to be used with AWS wind data. Example problem 5, appendix II, illustrates the use of the plotting scale with AWS upper air wind data.

22. AWS Constant Pressure Surface (ISOBARIC) Wind Data

a. The AWS detachments attached to major command headquarters within the field army have the capability of providing estimates of the wind structure, using constant pressure surface charts. When local upper air wind data are not available, the wind structure determined from constant pressure surface charts may be used to prepare a local fallout wind vector plot. In addition to supplementing local artillery and AWS wind measurement capabilities, the constant pressure surface charts can be used for two special purposes:

(1) Inasmuch as they cover very large areas, they may be used to obtain upper air wind data for fallout prediction at *distant locations.*

(2) They may also be used to forecast wind speeds and directions used for fallout predictions for periods from 24 to 48 hours.

b. A constant pressure surface chart depicts the altitude at any location at which a specific pressure surface will be found. From these constant pressure surface charts, the wind directions and speeds can be obtained for various altitudes. The following constant pressure surfaces above mean sea level are used for this purpose:

Constant pressure surface (millibars)	*Average altitude (feet)*
850	5,000
700	10,000
500	18,000
300	30,000
100	53,000

The wind directions obtained are reported in degrees *from* which the wind is blowing, and the wind speeds are reported in knots. Weighting factors and plotting scale data required for preparation of the fallout wind vector plot from AWS isobaric wind data are included in table V (app. III).

c. Example problem 6, appendix II, illustrates the use of the plotting scale with AWS isobaric wind data.

23. Other Wind Reporting Systems

a. In the event that upper air wind data are not available from any of the wind reporting systems mentioned in this chapter, other types of wind data may have to be used. Under these circumstances the fallout wind vector plot will be prepared by converting the units of reported data and following the procedure established by example problem 3, appendix II. In this case, weighting factors will be determined from time-of-fall data from figure 16.

b. Example problem 7, appendix II, illustrates the conversion and weighting factor problems of preparing a fallout wind vector plot from data available from other wind reporting systems.

24. Minimum Requirements for Fallout Wind Vector Plot

a. Regardless of the procedures applied, the resulting wind vector plot must contain the following minimum requirements:

(1) A labeled GZ point.

(2) The plot of vectors for each wind layer, starting from the surface and proceeding upward consecutively to the highest observed wind level. Each vector must represent the distance in kilometers and direction that a nominal size particle would travel over the surface while falling through the layer.

(3) Identification of each wind layer by designating the height levels, in thousands (10^3) of feet or meters (m), of the top and bottom of the wind layer on the vector plot.

(4) Scale of the wind vector plot.

(5) A grid north line.

b. The fallout wind vector plot may show the wind data source and the time and location at which the wind data were obtained.

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CHAPTER 6

DETAILED FALLOUT PREDICTION TECHNIQUES

25. General Procedure

The detailed fallout prediction is prepared by the CBRE in a sequence of well-defined steps.

a. Step 1. Prepare the fallout wind vector plot.

b. Step 2. Determine nuclear burst input data.

c. Step 3. Determine cloud parameters.

d. Step 4. Determine lateral limits of fallout and expand, if necessary.

e. Step 5. Determine effective wind speed.

f. Step 6. Determine downwind distances of Zones I and II.

g. Step 7. Complete the fallout prediction.

h. Step 8. Prepare and disseminate the fallout prediction message. The nomograms used to prepare the detailed fallout prediction are grouped together in appendix III.

26. Detailed Procedure

a. Step 1. Preparation of Fallout Wind Vector Plot. Prepare the fallout wind vector plot as described in chapter 5. The fallout wind vector plot is prepared each time new upper air wind data are received; every prediction made from the current fallout wind vector plot should be prepared on a separate overlay so that the current fallout wind vector plot may be saved for further use. The fallout wind vector plot is drawn to any convenient map scale.

b. Step 2. Determination of Nuclear Burst Information (par. 6*b*). A convenient worksheet for recording data for the detailed fallout prediction method is shown in figure 6. This worksheet may be reproduced locally.

c. Step 3. Determination of Cloud Parameters. Cloud parameters are read from figure 17. Enter figure 17 with the yield by placing a straight-edge so that the values on the left yield index scale and on the right yield index scale are the same and read all parameters under the straight-edge.

d. Step 4. Initial Determination of Lateral Limits of the Fallout Prediction. Mark points representing the cloud-top height, cloud-bottom height, and two-thirds stem height on the fallout wind vector plot, and draw radial lines from the ground zero point through these height points (interpolate linearly along a wind vector if necessary) (1, fig. 14). Disregard all wind vectors below the two-thirds stem height point and above the cloud-top height point for the prediction being prepared. If wind vectors *between* the two-thirds stem height point and the cloud-top height point fall outside the radial lines drawn from ground zero through these points, expand the angle formed by these two radial lines to include these outside wind vectors.

e. Step 5. Determination of the Effective Wind Speed. Measure the length of the radial line, in kilometers, from GZ to the cloud-bottom height point (2, fig. 14). Read the time of fall from the cloud bottom from worksheet (fig. 6, item j). Compute the effective wind speed as follows:

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

f. Step 6. Determination of the Downwind Distances of Zones I and II.

(1) Using figure 18, aline a straightedge from the yield on the left-hand scale to the value of the effective wind speed on the right-hand scale; at the intersection of the straightedge with the center scale, read the value of the downwind distance of the Zone of Immediate Operational Concern (Zone I) for a contact surface burst.

(2) If the height of burst is known, obtain the height of burst adjustment factor from figure 19 for yields equal to or less than 100 KT or from figure 20 for yields greater than 100 KT. Lay a straightedge from the yield on the left-hand scale to the value of the height of burst on the center scale; at the intersection of the straightedge with the right-hand scale, read the height of burst adjustment factor. If height of burst is not known, assume a zero height of burst and use a height of burst adjustment factor of 1.

(3) If FY/TY ratio is known, obtain the FY/TY adjustment factor from figure 21. Lay a straightedge from the total yield on the left-hand scale to the value of the FY/TY ratio on the right-hand scale; at the intersection of the straightedge with the center scale, read the FY/TY adjust-

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a. Time of Burst (date-time group) ______________ ZULU DDtttt

b. GZ Coordinates ______________ FOXTROT yyzzzzzz

c. FY/TY Ratio (from target analyst for friendly weapons only) ______________

d. HOB (from target analyst for friendly weapons only) ______________ meters

e. Yield ______________ KT or MT

f. Cloud-top Height (fig. 17) ______________ 10^3 meters or feet

g. Cloud-bottom Height (fig. 17) ______________ 10^3 meters or feet

h. ⅔ Stem Height (fig. 17) ______________ 10^3 meters or feet

i. Stabilized Cloud Radius (fig. 17) ______________ HOTEL rr (km)

j. Time of Fall from Cloud Bottom (fig. 17) ______________ hours

Fallout Wind Vector Plot (Enter f, g, & h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to Cloud-bottom Height ______________ km

l. Effective Wind Speed = $\frac{k \text{ (GZ-CB dist)}}{j \text{ (Time of fall)}}$ = ______________ $\frac{km}{hr}$ = ______________ HOTEL ss (km/hr)

m. Downwind Distance of Zone I (Enter fig. 18 with l and e.) ______________ km

n. Adjustment = FY/TY Factor ______________ × HOB Factor ______________ = ______________
(Enter fig. 21 with e and c or use one.) (Enter fig. 19 or 20 with d and e or use one.)

o. Adjusted Downwind Distance of Zone I (m × n) ______________ HOTEL xxx (km)

Fallout Wind Vector Plot (Check lateral limits for 40 degrees.)

p. Azimuth of Left Radial Line ______________ GOLF ddd (degrees)

q. Azimuth of Right Radial Line ______________ GOLF ccc (degrees)

r. Fallout Prediction Message:

ZULU	DDtttt	___ ___ ___ ___ ___ ___	(date-time group)
FOXTROT	yyzzzzzz	___ ___ ___ ___ ___ ___ ___ ___	(GZ coordinates)
GOLF	dddccc	___ ___ ___ ___ ___ ___	(azimuths of radial lines)
HOTEL	ssxxxrr	___ ___ ___ ___ ___ ___ ___	
		(effective wind speed) (downwind distance) (cloud radius)	

Figure 6. Detailed fallout prediction worksheet.

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ment factor. If the FY/TY ratio is not known, assume the yield to be 100 percent fission and use an FY/TY adjustment factor of 1.

(4) Multiply the Zone I downwind distance for a surface burst, determined in (1) above, by both the height of burst adjustment factor and the FY/TY adjustment factor to obtain the adjusted downwind distance of Zone I for the given conditions.

(5) Double the distance found in (4) above to obtain the adjusted downwind distance of the Zone of Moderate Risk (Zone II).

g. Step 7. Completion of the Fallout Prediction.

(1) Measure the angle formed by the radial lines drawn from ground zero to the cloud-top height and two-thirds stem height points on the fallout wind vector plot. If the angle formed is 40 degrees or greater, proceed as outlined below. If the angle formed is less than 40 degrees, bisect the angle, expand the angle formed by the two radial lines to 40 degrees (20 degrees on each side of the bisector), and then proceed as outlined below (3, fig. 14). (The fallout wind vector plot is no longer needed for this prediction after the lateral limits of fallout and the effective wind speed have been determined.)

(2) Start with GZ on an overlay at the selected map scale, and extend the radial lines at their proper azimuths to any convenient distance. Mark grid north on this overlay. (The fallout wind vector plot was originally drawn to a convenient map scale, for example, 1:500,000. If it is more convenient, a different map scale can now be used to complete the fallout prediction.)

(3) Between the two radial lines drawn from ground zero, and using ground zero as center, draw two arcs with radii equal to the downwind distances found in step 6 (4, fig. 14).

(4) Using ground zero as center, draw a circle around ground zero with a radius equal to the cloud radius at the selected map scale (5, fig. 14).

(5) Draw two tangents extending from the ground zero circle to the points of intersection of the two radial lines with the arc representing the downwind distance of Zone I (6, fig. 14).

(6) Using ground zero as center, indicate the estimated times of arrival of fallout by drawing dashed arcs downwind at distances equal to the product of the effective wind speed and each hour of interest (7, fig. 14).

h. Step 8. Preparation and Dissemination of the Detailed Fallout Prediction Message.

(1) Measure the azimuths, in degrees from grid north, of the left and right radial lines.

(2) Prepare the message, using the format of paragraph 9. Data entered in the HOTEL line of the fallout prediction message are rounded off to the nearest kilometer or kilometer per hour.

(3) Disseminate the message in accordance with unit SOP.

*i. **Example**.* Example problem 8, appendix II, illustrates the preparation of a detailed fallout prediction.

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CHAPTER 7

EFFECTIVE WIND MESSAGE

27. Calculation of Effective Wind Speed and Direction

The effective wind speed and direction are calculated from the fallout wind vector plot at the CBRE. This information is transmitted through channels down to company and battery level for use with the simplified fallout predictor each time upper air wind data are received. Calculations are made as described below:

a. Step 1. Obtain from figure 17 the cloud-top height, cloud-bottom height, two-thirds stem height, and time of fall from cloud bottom for 2–KT, 5–KT, 30–KT, 100–KT, and 300–KT bursts.

Yield (KT)	*Cloud-top height (meters)*	*Cloud-bottom height (meters)*	*2/3 stem height (meters)*	*Time of fall from cloud bottom (hours)*
2 (ALFA)	4,500	2,700	1,500	0.90
5 (BRAVO)	7,200	4,700	3,000	1.46
30 (CHARLIE)	12,600	9,000	6,000	2.56
100 (DELTA)	16,400	11,900	8,000	3.22
300 (ECHO)	19,600	14,500	9,600	3.75

b. Step 2. Place a sheet of overlay paper over the wind vector plot, and mark a grid north reference line and ground zero. Mark the cloud-top height, cloud-bottom height, and two-thirds stem height for the 2-KT yield (use the values given in step 1). Draw radial lines from ground zero through these three points (1, fig. 7).

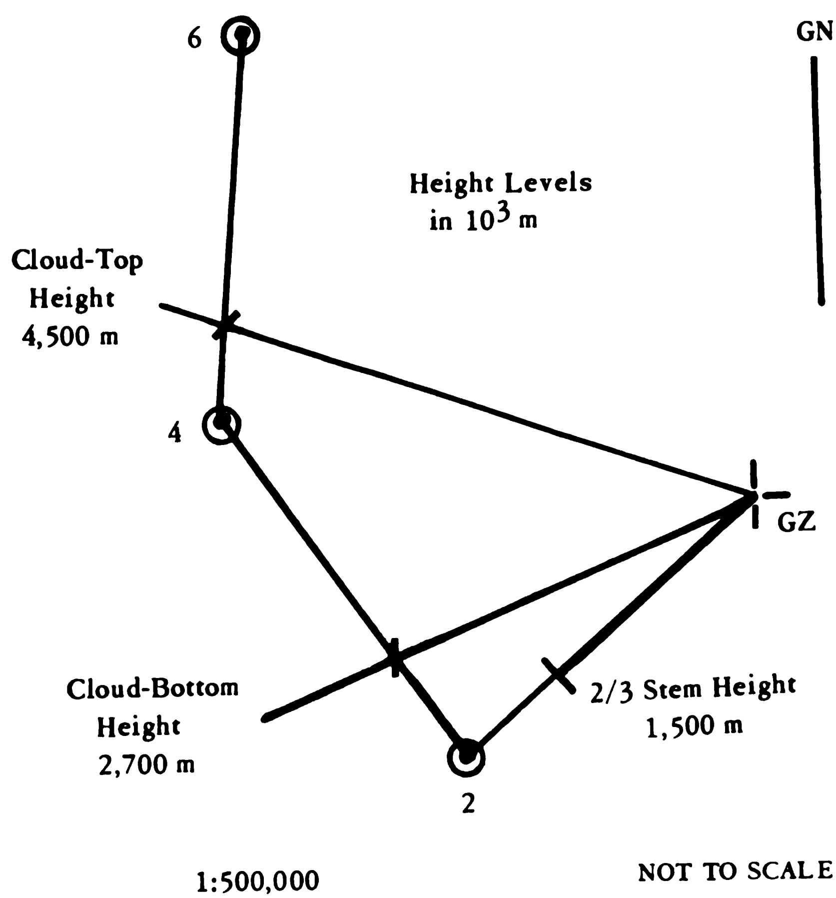


Figure 7. (1) *Effective wind speed and direction.*

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Note. If any vector of the wind vector plot *between* the two-thirds stem height point and the cloud-top height point falls outside the area enclosed by the two radial lines drawn from ground zero through these two points, move either one or both radial lines so as to enclose these outside wind vectors. A radial line that has been shifted will still be understood to have the same nomenclature as the original line before shifting.

c. Step 3. To determine the effective wind speed, measure the distance along the cloud-bottom radial line from ground zero to its intersection with the wind vector plot at the cloud-bottom height point, and divide this distance by the time of fall from the cloud bottom (2, fig. 7).

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

$$= \frac{25 \text{ km}}{0.9 \text{ hr}} = 27.7 \text{ km/hr} = 28 \text{ km/hr*}$$

* Round off to nearest kilometer per hour.

d. Step 4. To determine the effective wind direction, use a protractor to bisect the angle formed by the cloud-top height radial line and the two-thirds stem height radial line. Measure the azimuth of the bisector in degrees from grid north. This is the effective wind direction (3, fig. 7).

e. Step 5. Repeat steps 2, 3, and 4 for the remaining yields listed in step 1, using a separate sheet of overlay paper for each yield.

f. Step 6. Transmit the effective wind message as described in paragraph 12.

28. Calculation of Effective Wind Speed and Direction

(Constant Pressure Surface Type of Wind Vector Plot)

Procedures for preparing the effective wind message from a constant pressure surface type of wind vector plot vary from the procedure in paragraph 27. The procedures to be used are described below:

a. Step 1. On the constant pressure surface type of wind vector plot (fig. 13), draw radial lines from ground zero through the end of each vector and through the midpoint of the 30 to 53,000 foot vector (midpoint of 100 millibar vector). This midpoint

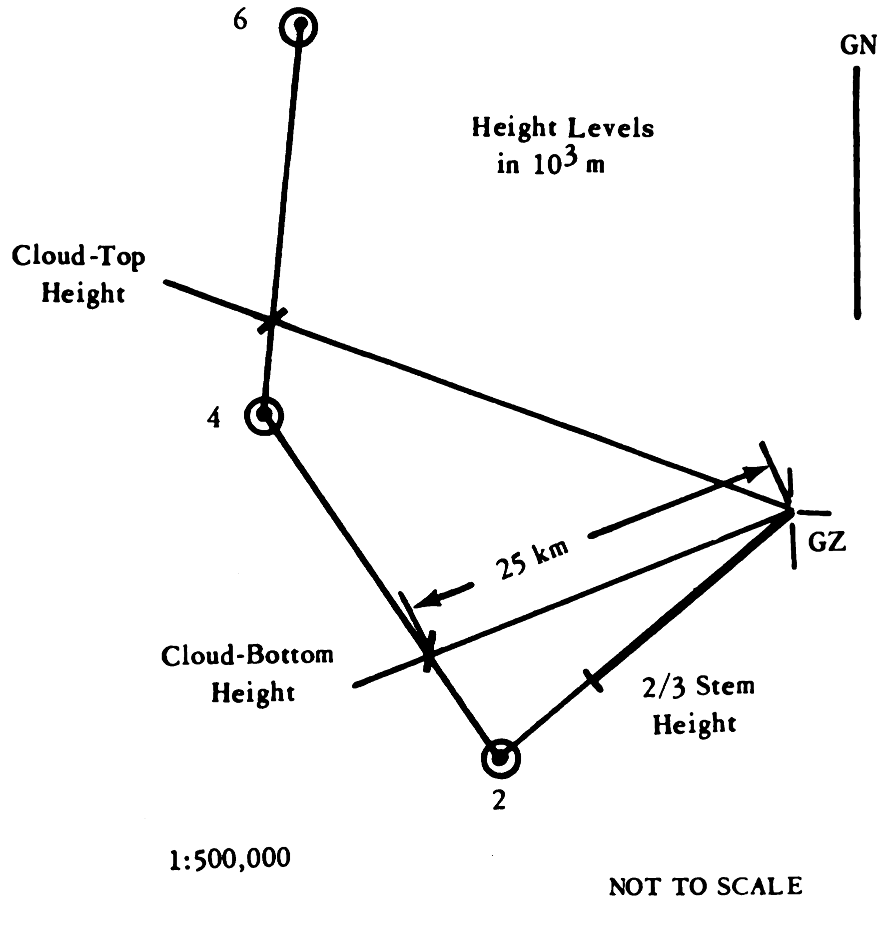


Figure 7 (2)—Continued.

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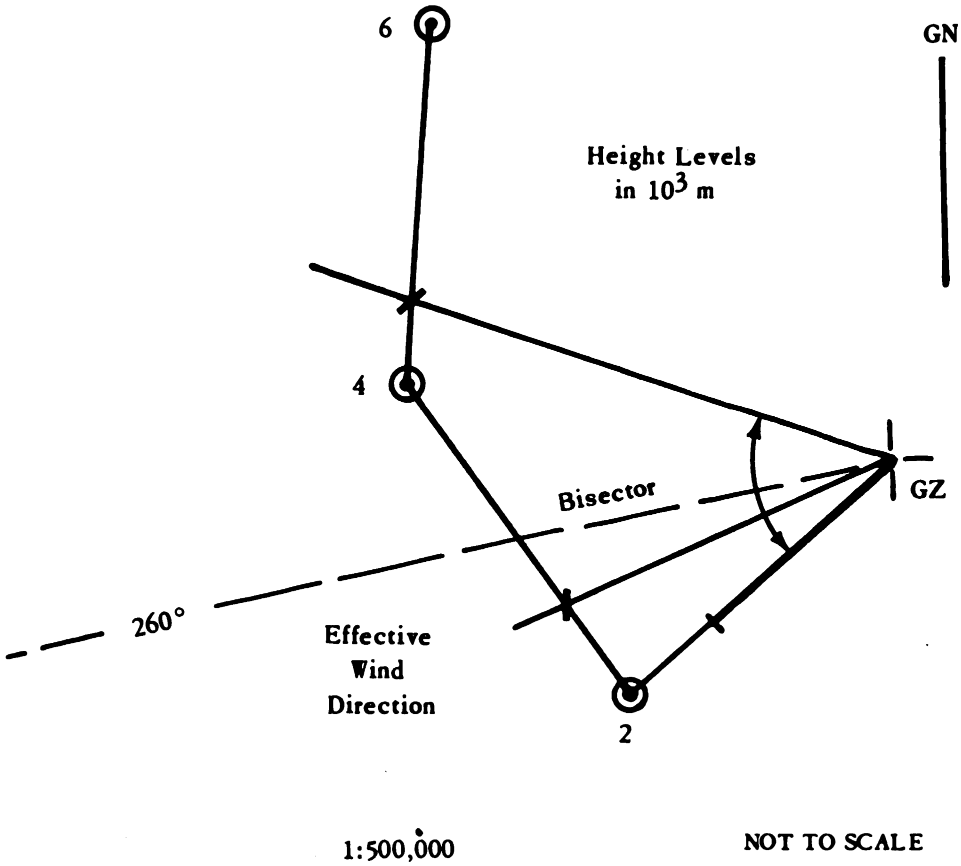


Figure 7 (3)—Continued.

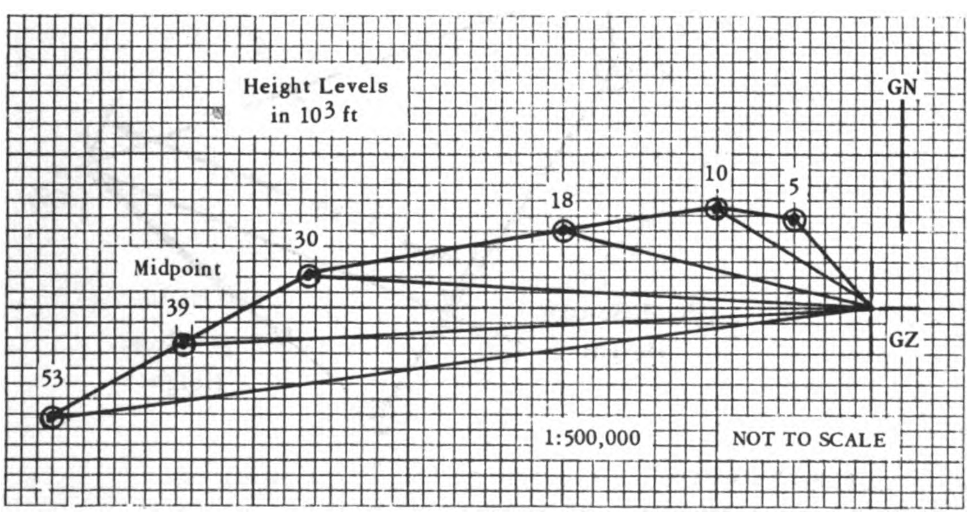


Figure 8. Effective winds (constant pressure surface data).

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corresponds approximately to the 39,000 foot height point.

b. Step 2. Calculate the effective wind directions and speeds. The selected pressure levels represent average altitudes which correspond *approximately* to the cloud-bottom heights of the yields used in the simplified fallout prediction system.

Constant pressure surface (mb)	*Average altitude (approximate cloud-bottom height) (ft)*	*Yield (KT)*
700	10,000	2 (A)
500	18,000	5 (B)
300	30,000	30 (C)
100 mb (midpoint)*	39,000	100 (D)
100	53,000	300 (E)

* The midpoint of the 300 to 100-millibar vector (30,000 to 53,000 foot vector) corresponds approximately to the height of the bottom of the cloud for a 100-KT weapon (about 39,000 feet).

(1) Measure the azimuth of each radial line drawn on the constant pressure surface type of wind vector plot (*a* above) which corresponds to one of the average altitudes listed above. These azimuths *are* the effective wind directions.

Constant pressure surface (millibars)	*Yield group*	*Azimuth (degrees)*
700	A (2 KT or less)	304
500	B (2+ to 5 KT)	284
300	C (5+ to 30 KT)	273
100 mb (midpoint)	D (30+ to 100 KT)	267
100	E (100+ to 300 KT)	262

(2) Measure the length in kilometers of each radial line, and divide these radial distances by the times of fall taken from figure 17. The results are the effective wind speeds, as shown below. Figure 22 may be used to facilitate division operations. To determine times of fall from figure 17, place a straightedge horizontally through the values in the "cloud-bottom height" column that are equal to the altitudes of the constant pressure surfaces, and read times of fall from the column entitled "time of fall."

Constant pressure surface (mb)	*Yield group*	*Radial distance (km)*	÷	*Time of fall (hr)*	=	*Effective wind speed (km/hr)**
700	A (2 KT or less)	31.1		1.00		31
500	B (2+ to 5 KT)	53.2		1.66		32
300	C (5+ to 30 KT)	93.7		2.57		36
100 mb (midpoint)	D (30+ to 100 KT)	115.7		3.20		36
100	E (100+ to 300 KT)	135.7		4.08		33

* Round off to nearest kiolmeter per hour.

c. Step 3. Prepare the effective wind message.

Effective Wind Message

ZULU	301200
ALFA	30431
BRAVO	28432
CHARLIE	27336
DELTA	26736
ECHO	26233

29. Special Cases

a. If the effective wind speed is 100 kilometers per hour or greater, 99 is transmitted on the applicable line of the effective wind message.

b. The situation may arise when the effective wind speed for one or more yield groups is less than 8 kilometers per hour. In this case, determine the downwind distance from figure 18 for an effective wind speed of 8 kilometers per hour and the yield corresponding to the yield group of interest (par. 27*a*). The applicable line of the effective wind message will then contain only two digits, the downwind distance corresponding to 8 kilometers per hour. A direction is not transmitted for that yield group. The downwind distance, in this case, describes Zone I as a circle around ground zero.

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APPENDIX I

REFERENCES

AR 220–50	Regiments; General Provisions
AR 220–60	Battalions, Battle Groups, Squadrons; General Provisions
AR 320–5	Dictionary of United States Army Terms
AR 320–50	Authorized Abbreviations and Brevity Codes
FM 6–15	Artillery Meteorology
FM 21–5	Military Training
FM 21–6	Techniques of Military Instruction
FM 21–30	Military Symbols
TM 1–300	Meteorology for Army Aviation
DA Pam 108–1	Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings
DA Pam 310–1	Index of Administrative Publications
DA Pam 310–3	Index of Training Publications
DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders
DA Pam 310–5	Index of Graphic Training Aids and Devices
DA Pam 310–7	Index of Tables of Organization and Equipment, Type Tables of Distribution, and Tables of Allowances

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APPENDIX II

EXAMPLE PROBLEMS

1. EXAMPLE PROBLEM 1. PREPARATION OF A DETAILED FALLOUT PREDICTION FROM THE FALLOUT PREDICTION MESSAGE

a. Situation. S3, 3*d* Bn, 63*d* Inf, receives a fallout warning over the division warning net for the following predicted area:

Fallout Prediction Message

ZULU	240700
FOXTROT	MN340670
GOLF	252292
HOTEL	1903005

b. Action. Prepare the detailed fallout prediction. The first line, ZULU, gives the date and time of the burst. The second line, FOXTROT, gives the coordinates of ground zero, MN340670. The third line, GOLF, gives the azimuths of the left and right radial lines of the predicted area, 252 degrees and 292 degrees respectively. The first three digits, 252, indicate that the left radial line is 252 degrees from grid north; the second three digits, 292, indicate that the right radial line is 292 degrees from grid north. The fourth line, HOTEL, has three sets of digits. The 19 is the effective wind speed in kilometers per hour. The effective wind speed multiplied by the time in hours after the burst gives the estimated times of arrival of fallout. The 030 is the predicted downwind distance, in kilometers, of the Zone of Immediate Operational Concern (Zone I). The Zone of Moderate Risk (Zone II) is twice the downward distance of Zone I, or 60 kilometers. The last two digits give the cloud radius as 5 kilometers. The fallout prediction is shown in figure 9, with arrows indicating the use of the prediction dimensions derived from the message and used to construct the prediction.

2. EXAMPLE PROBLEM 2. USE OF THE SIMPLIFIED FALLOUT PREDICTOR

a. Situation. S3, 2*d* Bn, 62*d* Inf, has the following effective wind message available:

Effective Wind Message

ZULU	240600
ALFA	08015
BRAVO	08515
CHARLIE	09020
DELTA	10010
ECHO	11025

At about 240730Z a nuclear burst which is estimated to be a 20–KT surface burst occurs in an adjacent area at MN553298.

b. Action. Use the simplified fallout predictor to make a fallout prediction. The estimated yield (20 KT) lies within the yield group CHARLIE (5+ to 30 KT). Therefore, use the effective wind direction and speed from line CHARLIE of the effective wind message, and use the "C" contour of the fallout predictor. From the nomogram on the predictor, using a yield of 20 KT and an effective wind speed of 20 kilometers per hour, read the downwind distance of the Zone of Immediate Operational Concern to be 18 kilometers (fig. 3). Draw an arc between the radial lines of the predictor at a distance of 18 kilometers downwind from ground zero (fig. 10). Double this distance and draw a second arc between the radial lines of the predictor at a distance of 36 kilometers downwind from ground zero. Draw straight lines from the outside of the 30–KT semicircle to the intersection points of the 18-kilometer arc with the radial lines. The area enclosed by the two lines, the ground zero semicircle and the 18-kilometer arc, is the predicted Zone of Immediate Operational Concern (Zone I). The area enclosed by the 18-kilometer and 36-kilometer arcs and the radial lines is the predicted Zone of Moderate Risk (Zone II). Then with a distance equal to the product of the effective wind speed (20 kilometers per hour) and the number of hours after the burst, draw a series of arcs (dashed lines in figure 10) to represent the times of arrival of fallout (20 kilometers at H + 1, 40 kilometers at H + 2). Place GZ of the predictor over the estimated or assumed GZ on the map (the scales of the map and predictor must correspond), and orient the effective wind direction (90 degrees) with grid north. Figure 10 shows the completed fallout prediction for this example.

3. EXAMPLE PROBLEM 3. PREPARATION OF WIND VECTOR PLOT (Artillery Wind Reporting System; not using plotting scale)

a. Situation. It is assumed that the following artillery upper air wind data have been received by the CBRE:

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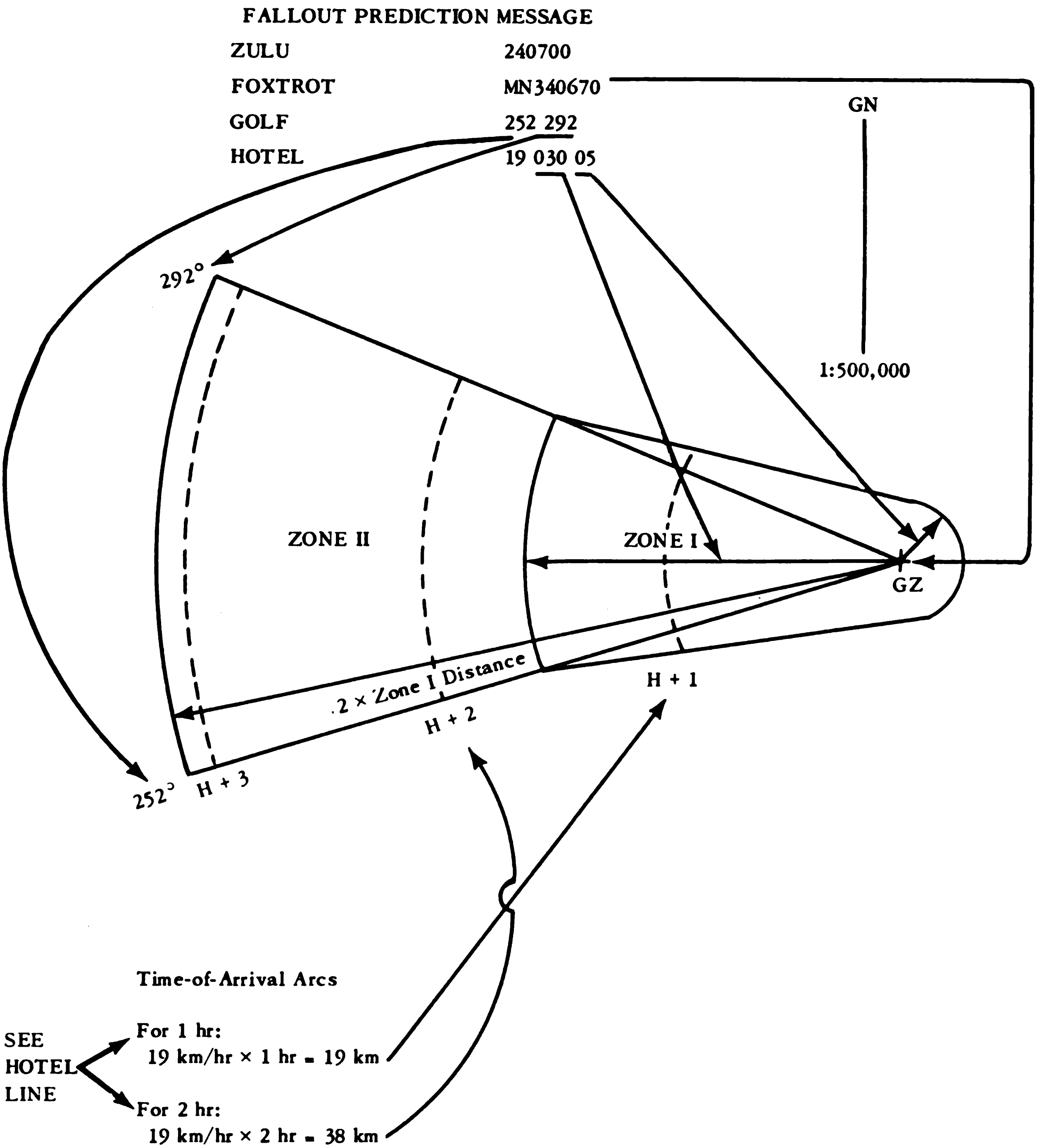


Figure 9. Detailed fallout prediction construction.

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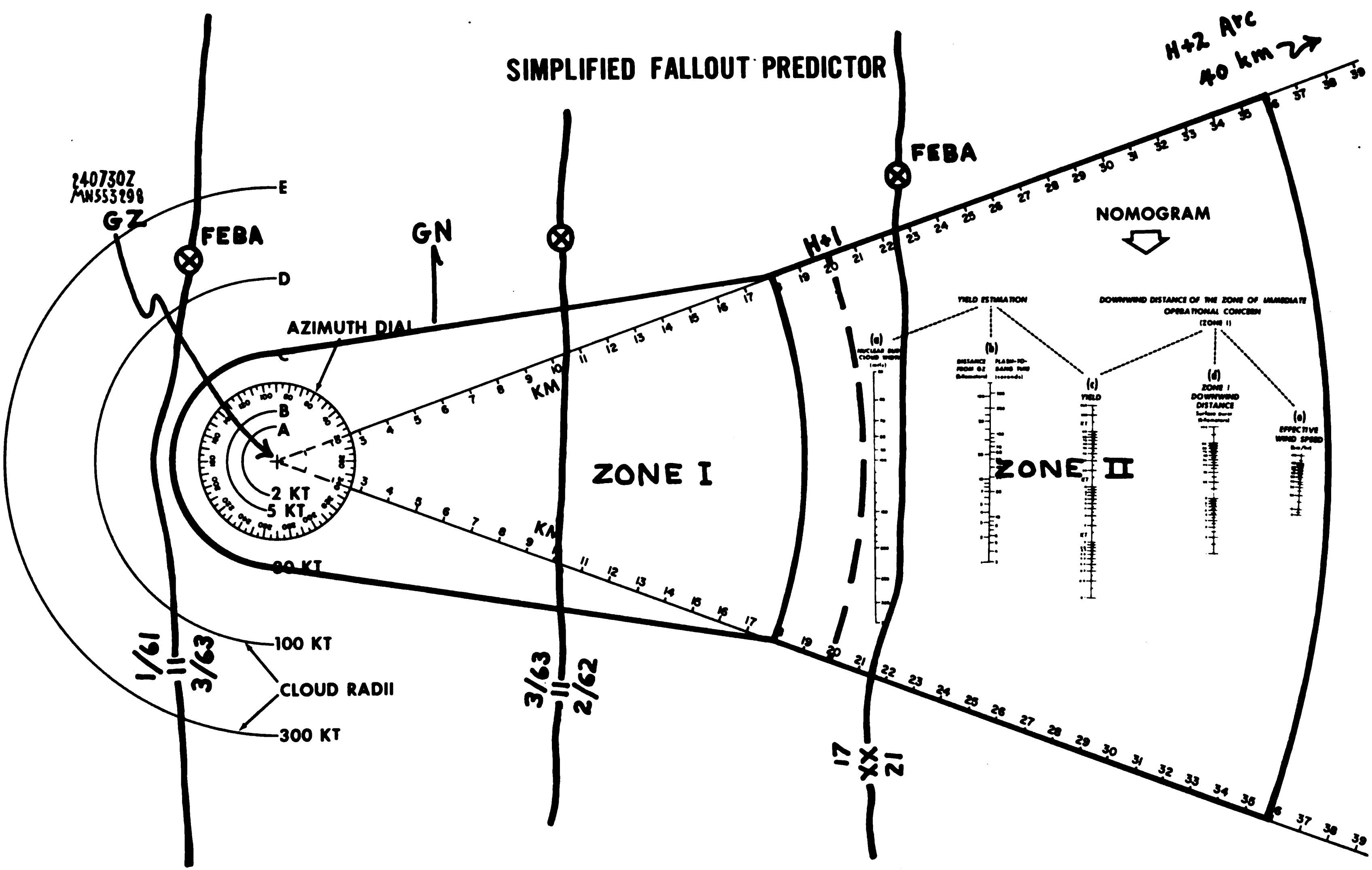


Figure 10. Simplified fallout prediction for a 20-KT Field.

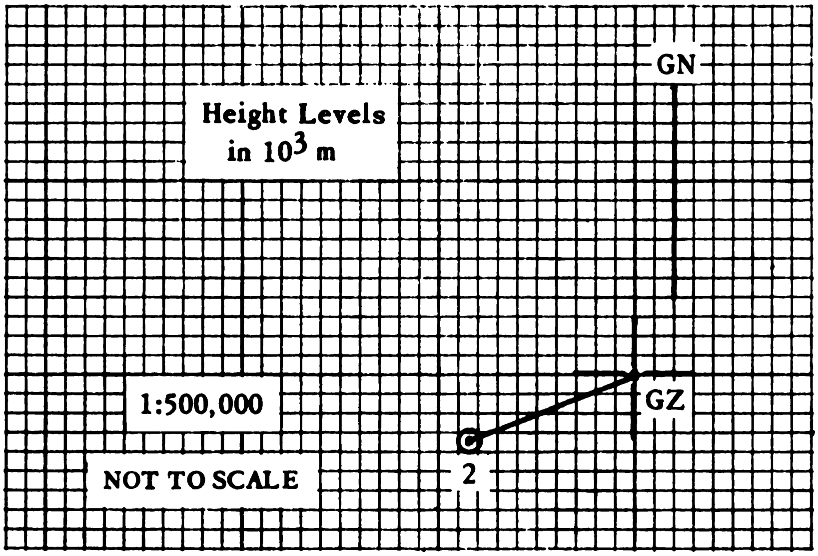


Figure 11. (1) *Example problem 3.*

Wind layer (10³ meters)	*Wind direction (tens of mils)*	*Wind speed (knots)*
0–2	124	9
2–4	142	13
4–6	160	18
6–8	178	13
8–10	196	9
10–12	231	9
12–14	285	13
14–16	320	13
16–18	356	18
18–20	374	14
20–22	382	18
22–24	391	27
24–26	391	26
26–28	391	34
30 Balloon Burst		

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* Adjust wind data.

(*a*) The direction reported in the wind message is the direction from which the wind is blowing. Using the reported direction, obtain the direction toward which the fallout particles are being blown while falling through a wind layer by adding or subtracting 3,200 mils as applicable.

(*b*) The horizontal distance in kilometers traveled by a nominal size particle while falling through a wind layer is obtained by multiplying the reported wind speed in knots for the layer by the appropriate weighting factor from table III (app. III). A worksheet showing step 1 is given below:

Wind layer (10³ meters)	*Wind direction (tens of mils) From*	*To*	*Wind speed (knots)*	× *Weighting factor (from table III)*	= *Vector length (kilometers)**
0–2	124	444	9	1.26	11.3
2–4	142	462	13	1.09	14.2
4–6	160	480	18	.96	17.3
6–8	178	498	13	.93	12.1
8–10	196	516	9	.89	8.0
10–12	231	551	9	.83	7.5
12–14	285	605	13	.78	10.1
14–16	320	640	13	.74	9.6
16–18	356	036	18	.72	13.0
18–20	374	054	14	.70	9.8
20–22	382	062	18	.69	12.4
22–24	391	071	27	.67	18.1
24–26	391	071	26	.67	17.4
26–28	391	071	34	.65	22.1
30 Balloon Burst					

* Round off to nearest 0.1 kilometer.

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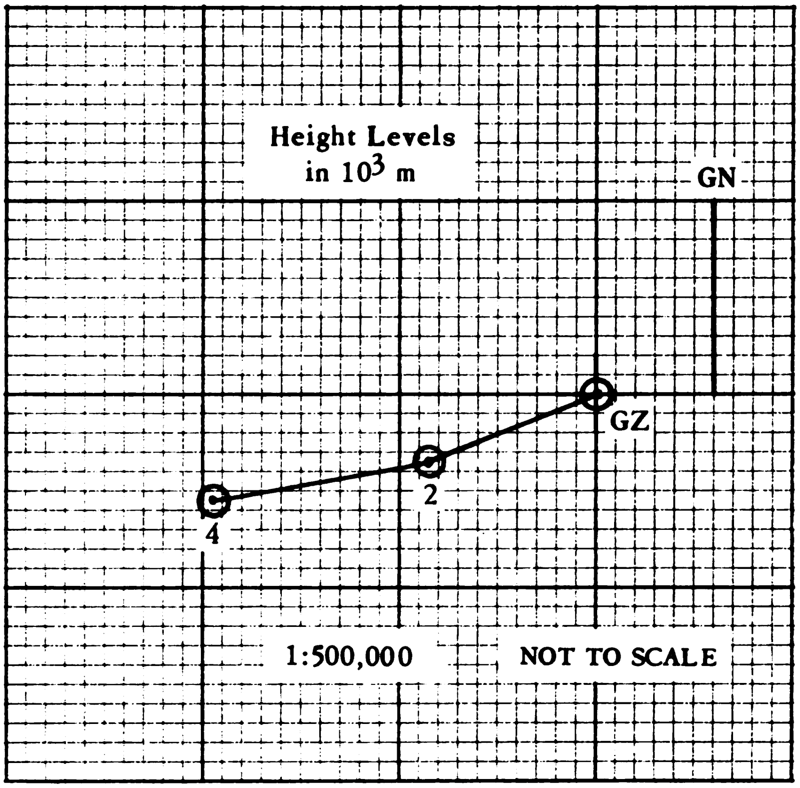


Figure 11(2)—Continued.

(2) *Step 2.* On a piece of graph paper, a map, a firing chart, or any other paper with a set of parallel lines that can serve as north-south grid lines, select and mark a point which represents ground zero and a grid north line.

(3) *Step 3.* Select and record a map scale. (In this situation, a map scale of 1:500,000 will be used.)

(4) *Step 4.* Plot the wind direction and adjusted speed for each wind layer, starting with the lowest layer.

(*a*) Plot the vector for the lowest (0- to 2,000-meter) wind layer which represents a wind with a speed of 9 knots blowing from 1,240 mils. From GZ plot a line toward 4,440 mils 11.3 kilometers long. Mark the end of this vector with the number 2 to indicate 2,000-meter height (1, fig. 11).

(*b*) Starting at the point where the first vector ended, plot the vector for the next (2,000- to 4,000-meter) layer which represents a wind with a speed of 13 knots blowing from 1,420 mils. This vector is plotted 14.2 kilometers long toward 4,620 mils. Mark the end of this vector with the number 4 to indicate 4,000-meter height (2, fig. 11).

(*c*) Starting at the point where the second vector ended, plot the third vector for the (4,000- to 6,000-meter) layer which represents a wind with a speed of 18 knots blowing from 1,600 mils. This vector is plotted 17.3 kilometers long toward 4,800 mils. Mark the end of this vector with the number 6 to indicate 6,000-meter height (3, fig. 11).

(*d*) Plot the remaining vectors in the same manner and label the end of each vector by the height it represents (4, fig. 11).

4. EXAMPLE PROBLEM 4. PREPARATION OF WIND VECTOR PLOT (Artillery Wind Reporting System; using plotting scale)

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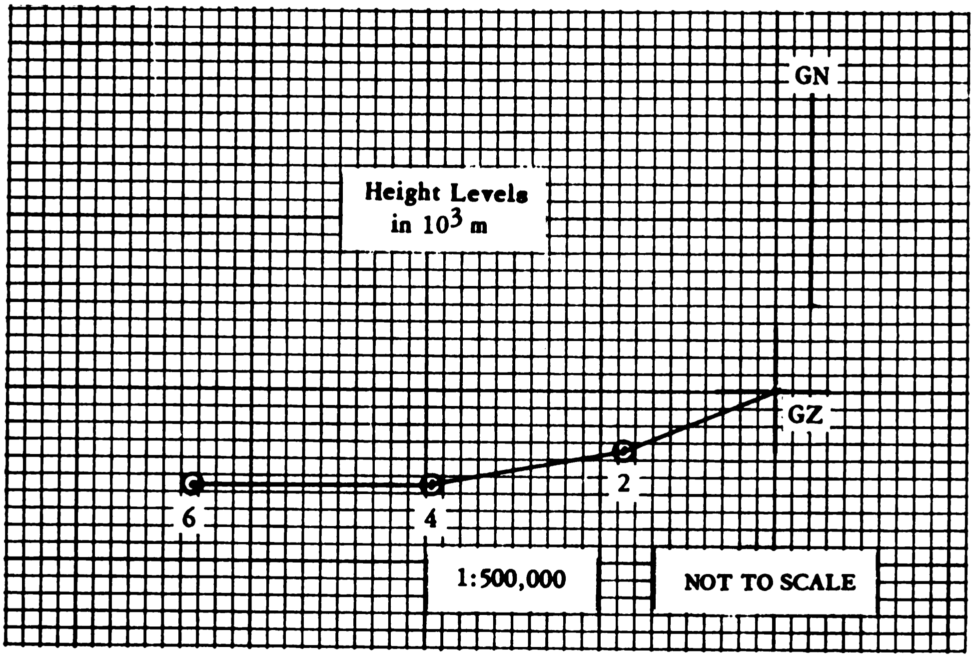


Figure 11(3)—Continued.

a. Situation. It is assumed that the following artillery upper air wind data have been received by the CBRE:

Wind layer (10³ meters)	*Wind direction (tens of mils)*	*Wind speed (knots)*
0–2	124	9
2–4	142	13
4–6	160	18
6–8	178	13
8–10	196	9
10–12	231	9
12–14	285	13
14–16	320	13
16–18	356	18
18–20	374	14
20–22	382	18
22–24	391	27
24–26	391	26
26–28	391	34
30 Balloon Burst		

b. Action. Using the wind vector plotting scale (fig. 5), prepare the fallout wind vector plot as follows:

(1) *Step 1.* (*Note.* Wind direction is received to the nearest 10 mils, but data are plotted as accurately as possible with the plotting scale.) Attach overlay paper to a piece of graph paper, a map, a firing chart, or any other paper with parallel lines that can serve as north-south grid lines. Mark GZ, scale, height dimensions, and grid north on the overlay paper. Place the pinhole at the end of slot 1 (marked "0–2") over the point marked GZ; stick a pin or sharp pencil through the hole to hold that pinhole on GZ; rotate the plotting scale until the 1,240-mil line on the compass rose (azimuth dial) is parallel to any north-south line and directed toward grid north; draw a line in slot 1 to 9 (9 knots) at the selected map scale. Mark the end of this vector with the number 2 to indicate 2,000-meter height (1, fig. 11).

(2) *Step 2.* Place the pinhole at the end of slot 2 (marked "2–4") at the end of the first vector; stick a pin or sharp pencil through the hole to hold the pinhole there; rotate the plotting scale until the 1,420-mil line on the compass rose is parallel to any north-south line and directed toward grid north; draw a line in slot 2 to 13 (13 knots) at the selected map scale. Mark the end of this vector with the number 4 to indicate 4,000-meter height (2, fig. 11).

(3) *Step 3.* Place the pinhole at the end of slot 3 (marked "4–6") at the end of the second vector; stick a pin or sharp pencil through the hole to hold the pinhole there;

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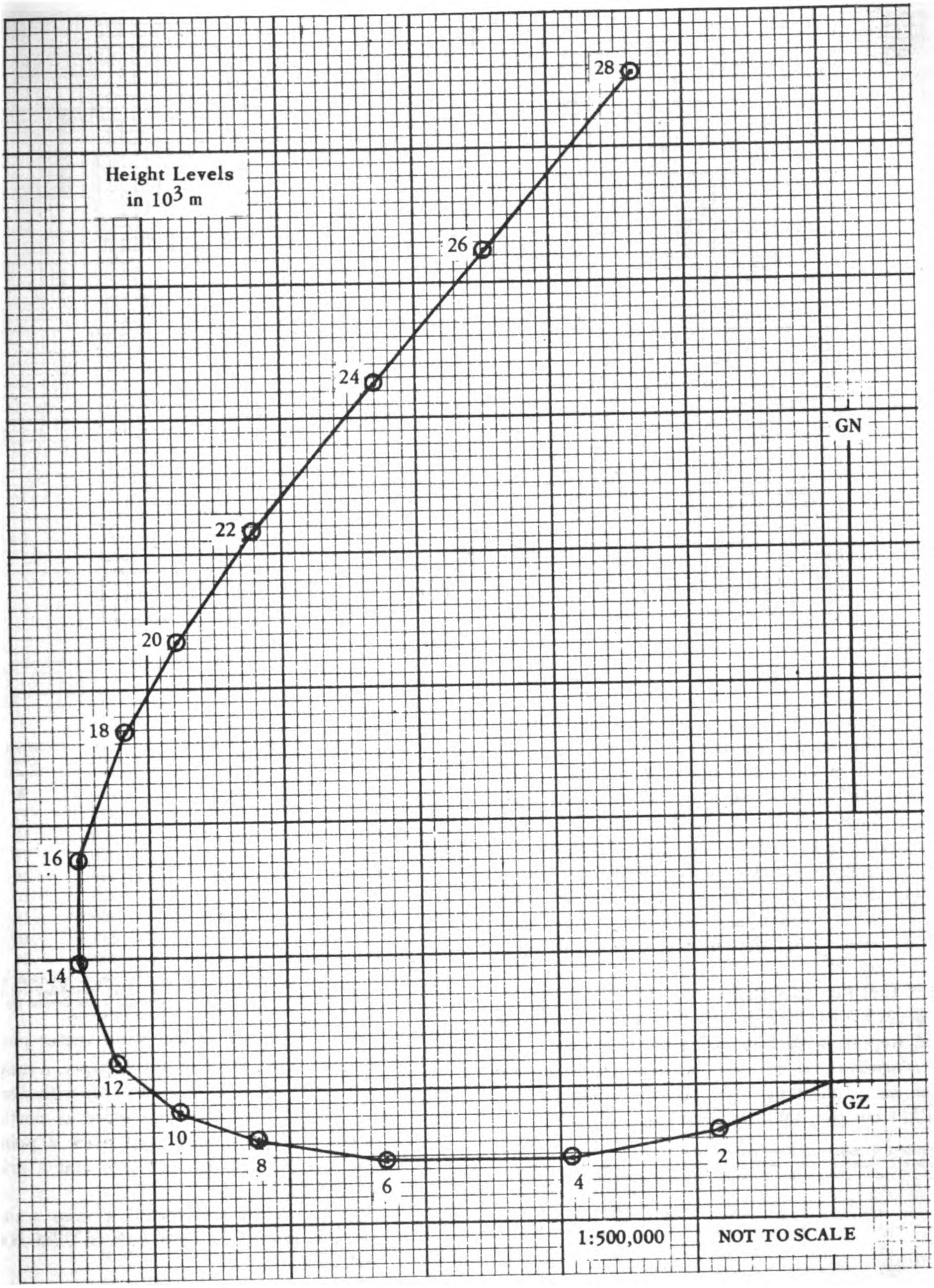


Figure 11(4)—Continued.

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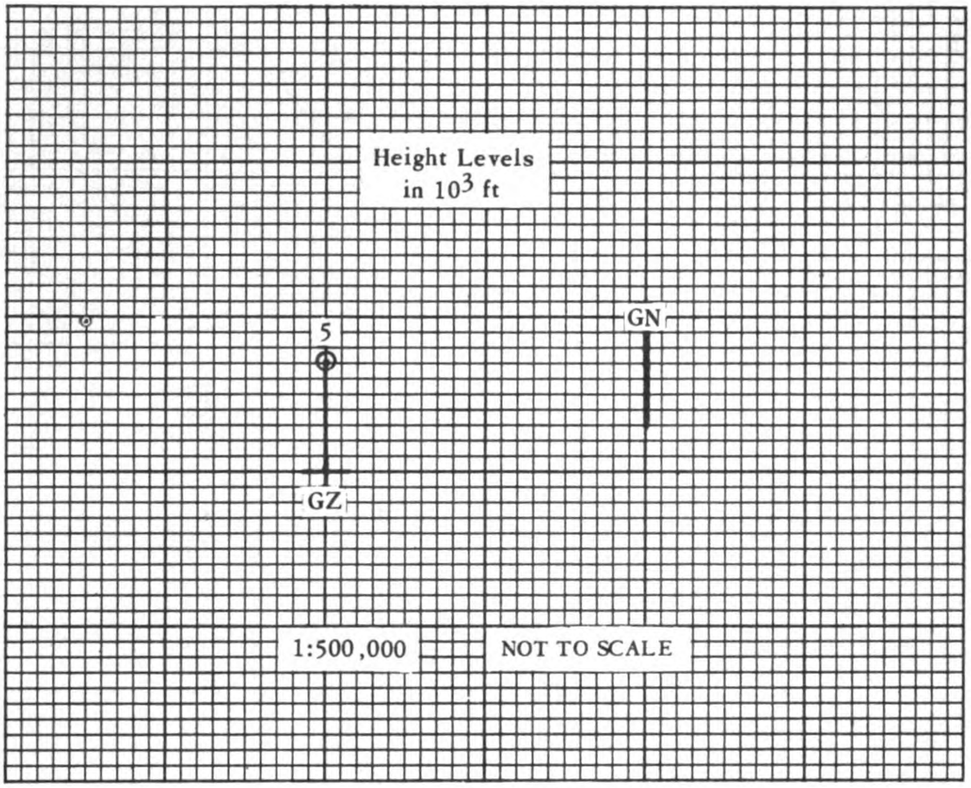


Figure 12. Example problem 5.

rotate the plotting scale until the 1,600-mil line on the compass rose is parallel to any north-south grid line and directed toward grid north; draw a line in slot 3 to 18 (18 knots) at the selected map scale. Mark the end of this vector with the number 6 to indicate 6,000-meter height (3, fig. 11).

(4) *Step 4.* Plot the remaining vectors in the same manner and label the end of each vector by the height it represents (4 fig. 11).

5. EXAMPLE PROBLEM 5. PREPARATION OF WIND VECTOR PLOT (Air Weather Service Wind Reporting System; using plotting scale).

a. Situation. It is assumed that the following upper air wind data have been received by the CBRE from the AWS detachment:

1 Altitude above mean sea level of reported wind (10^3 feet)*	*2* Representing layer over local mean datum plane (10^3 feet)	*3* Wind direction (degrees)	*4* Wind speed (knots)
5	0–5	180	9
10	5–10	190	9
15	10–15	210	13
20	15–20	210	17
25	20–25	230	17
30	25–30	250	13
35	30–35	260	26
40	35–40	310	20
45	40–45	310	17
50	45–50	320	18
55	50–55	320	18
60	55–60	320	10
65	60–65	320	10
70	65–70	320	18
75	70–75	340	18
80	75–80	320	24

* When local mean datum plane exceeds 5,000 feet above mean sea level, begin the plot with the 10,000-foot altitude of reported wind (col 1), and label vectors in 5,000-foot increments above the mean datum plane (subtract 5,000 feet from the figures listed in column 2 above).

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* On a piece of graph paper, a map, a firing chart, or any other paper with a set of parallel lines that can serve as north-south grid lines, select and mark a point which represents ground zero and a grid north line.

(2) *Step 2.* Select and record a map scale. (In this example a map scale of 1:500,000 will be used.)

(3) *Step 3.* Using the plotting scale, plot the vector for each wind layer starting with the lowest layer. These vectors are plotted

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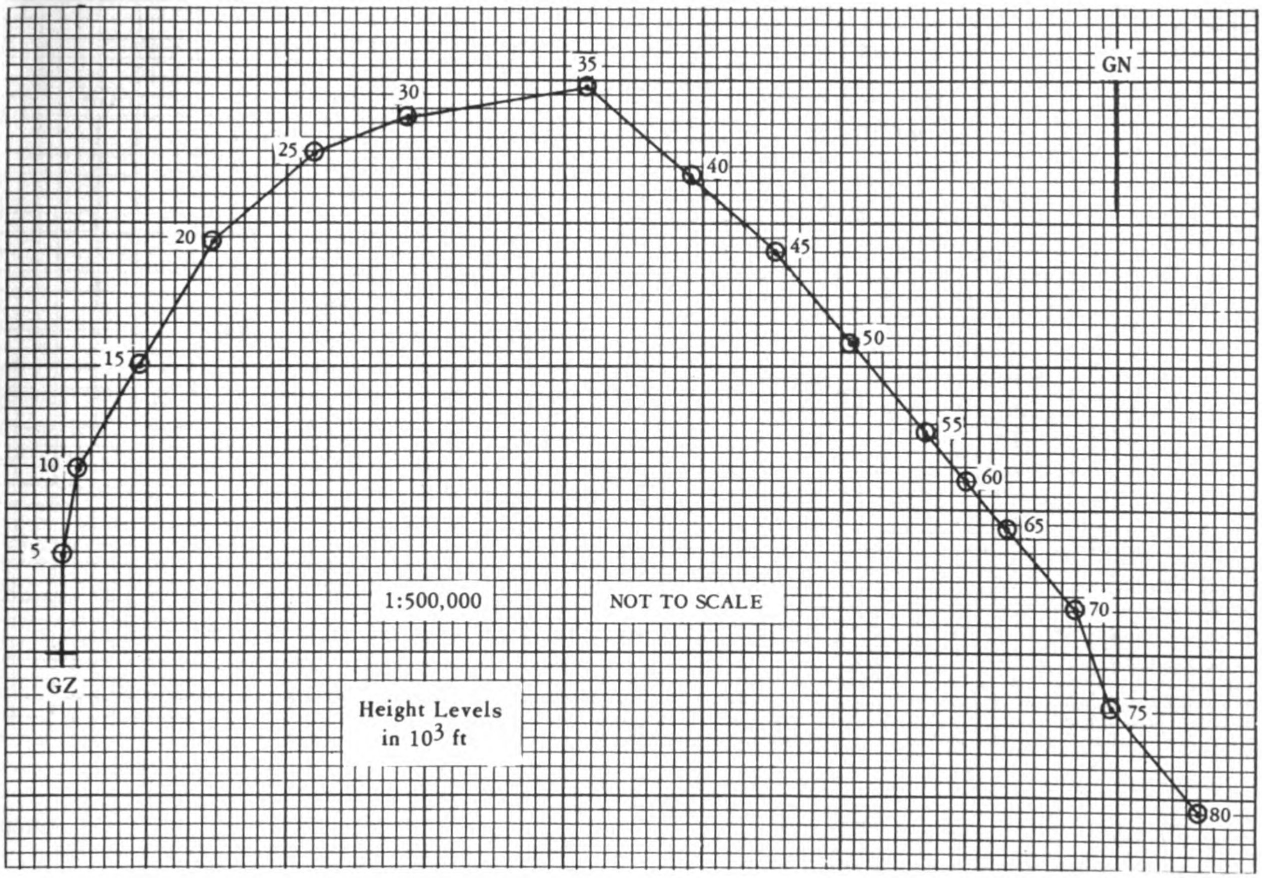


Figure 12(2)—Continued.

in the same manner as in example problem 4, except that different slots are used for the various wind layers and one-half the reported wind speeds are used for wind layers above 45,000 feet. Table IV, appendix III, shows which plotting scale slot to use for the various wind layers.

(*a*) Plot the 0- to 5,000-foot wind layer vector by placing the pinhole of the *6–8 slot* over the GZ point and rotating the plotting scale about the pinhole until the 180-degree line is parallel with grid north with the degree number up. Draw a line in the slot to the scaled value of 9 (9 knots). Mark the downwind end of this vector 5 to indicate the 5,000-foot height (1, fig. 12).

(*b*) Continue this procedure through the 40,000- to 45,000-foot layer, using the plotting scale slot for the various wind layers as indicated in table IV, appendix III.

(*c*) Plot the 45,000- to 50,000-foot wind layer vector by placing the pinhole of the *2–4 slot* over the end point of the 40,000- to 45,000-foot wind layer vector, and rotate the plotting scale about the pinhole until the 320-degree line is parallel with grid north with the degree number up. Draw a line in the slot to the scaled value of 9 (representing one-half of the 18-knot wind speed for the layer). Mark the downwind end of this vector 50 to indicate the 50,000-foot height.

(*d*) Plot the remaining vectors of the wind vector plot in the same manner, using the slot designated for each wind layer indicated in table IV, appendix III, and label the end of each vector by the height level it represents (2, fig. 12).

6. EXAMPLE PROBLEM 6. PREPARATION OF WIND VECTOR PLOT (AWS Constant Pressure Wind Reporting System; using plotting scale).

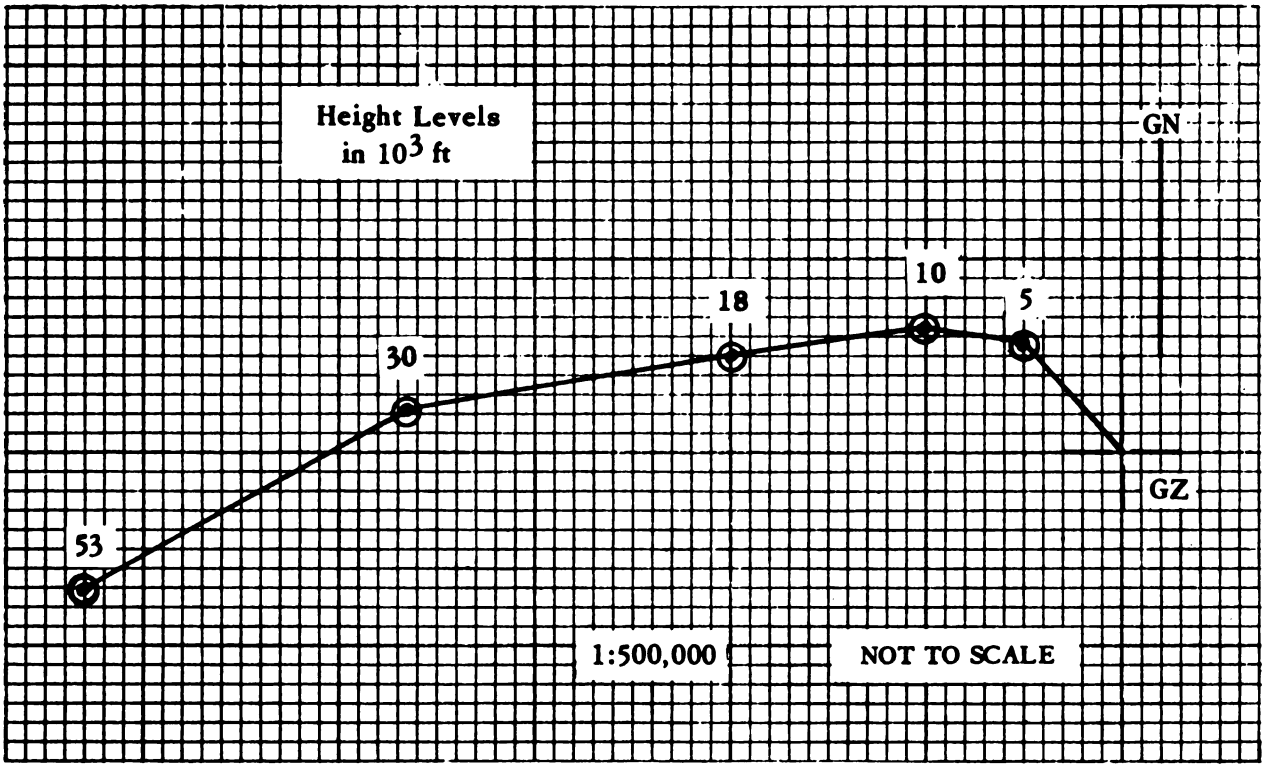


Figure 13. Example problem 6.

a. Situation. It is assumed that the following AWS meteorological data (constant pressure surfaces) have been received by the CBRE:

Constant pressure surface (millibars)	Wind direction (degrees)	Wind speed (knots)
850	140	20
700	100	16
500	080	21
300	080	25
100	060	17

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.*

(*a*) The plotting scale is used with constant pressure surface wind data in the same manner as in example problem 4, except that different slots are used for the different wind layers and the vector lengths are drawn to scaled values of each slot corresponding to adjusted wind speeds for each layer. The required slot designation and wind speed adjustment for each layer are established in table V (app. III).

(*b*) A worksheet showing step 1 is given below:

Constant pressure surface (millibars)	Represents wind layer (10^3 feet)	Wind direction (degrees)	Reported wind speed (knots) ×	Adjustment factor (from table V) =	Adjusted wind speed (knots)
850	0–5	140	20	1	20
700	5–10	100	16	1	16
500	10–18	080	21	1	21
300	18–30	080	25	2	50
100	30–53	060	17	4	68

(2) *Step 2.*

(*a*) Attach overlay paper to a piece of graph paper; mark GZ, scale, height dimensions, and grid north on the overlay paper. Place the pinhole of the *4–6 slot* of the plotting scale over the GZ point and rotate the plotting scale about the pinhole until the 140-degree line of the compass rose is parallel to grid north with the degree number up. Draw a line in the slot to the scaled number 20 (represents the adjusted wind speed for the 0- to 5,000-foot wind layer). Mark the downwind end of this vector 5 to indicate the 5,000-foot height.

(*b*) Place the pinhole of the *10–12 slot* over the end point of the first (0–5) vector, aline the plotting scale for a wind from 100 degrees and draw the second vector, using an adjusted wind speed of 16

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knots. Label the end point of this second vector 10.

(c) Repeat this process for the other wind layers using: *0–2 slot, 80 degrees*, and *21 knots* for the *10–18* wind layer; *8–10 slot, 80 degrees*, and *50 knots* for the *18–30* wind layer; and *18–20 slot, 60 degrees*, and *68 knots* for the *30–53* wind layer.

(d) See figure 13 for the completed wind vector plot.

7. EXAMPLE PROBLEM 7. PREPARATION OF WIND VECTOR PLOT (For wind data from sources other than artillery or AWS where weighting factor tables are not available and the plotting scale cannot be used)

a. Situation. It is assumed that the following upper air wind data have been received by the CBRE:

Wind layer (10³ meters)	*Wind direction (tens of mils)*	*Wind speed (meters/second)*
0–3	120	5
3–6	110	5
6–9	100	7
9–12	80	8
12–15	60	10
15–20	50	10
20–25	50	12
25–30	40	8

b. Action. Prepare the fallout wind vector plot.

(1) *Step 1.* Correct upper air wind data to find direction toward which the winds are blowing and convert the wind speeds from meters per second (m/sec) to kilometers per hour. To convert the direction from which the winds are blowing to the direction toward which the winds are blowing, add or subtract 3,200 mils as applicable for each wind layer. To convert wind speeds from meters per second to kilometers per hour, calculate the correction factor as shown below and multiply the wind speed for each layer by it.

$$\frac{1 \text{ meter}}{\text{sec}} \times \frac{1 \text{ km}}{10^3 \text{ meters}} \times \frac{3600 \text{ sec}}{1 \text{ hr}} = 3.6 \text{ km/hr}$$

A worksheet showing step 1 is given below:

Wind layer (10³ m)	*Wind direction (tens of mils) From*	*To*	*Reported wind speed (m/sec)* ×	*Correction factor (3.6)* =	*Adjusted wind speed (km/hr)**
0–3	120	440	5	3.6	18
3–6	110	430	5	3.6	18
6–9	100	420	7	3.6	25
9–12	80	400	8	3.6	29
12–15	60	380	10	3.6	36
15–20	50	370	10	3.6	36
20–25	50	370	12	3.6	43
25–30	40	360	8	3.6	29

* Round off to nearest kilometer per hour.

(2) *Step 2.* Determine the time the nominal size particle will spend in each layer. The time in layer is determined by first finding the time for the particle to fall from each height level to the surface from figure 16. The time in layer (weighting factor) is then found by subtracting the time to fall to the ground from the bottom of the layer from the time to fall to the ground from the top of the layer. A worksheet showing step 2 is given below:

Height level (10³ m)	*Time of fall to surface (hr) (fig. 16)*	*Wind layer (10³ m)*	*Fall time from top (hr)* minus	*Fall time from bottom (hr)* =	*Weighting factor (hr)*
3	.97	0–3	.97	0	.97
6	1.78	3–6	1.78	.97	.81
9	2.53	6–9	2.53	1.78	.75
12	3.20	9–12	3.20	2.53	.67
15	3.83	12–15	3.83	3.20	.63
20	4.82	15–20	4.82	3.83	.99
25	5.72	20–25	5.72	4.82	.90
30	6.60	25–30	6.60	5.72	.88

(3) *Step 3.* Determine the vector length in kilometers for each wind layer. This is the distance in kilometers that the nominal size particle travels while falling through each layer. This distance is determined by multiplying the wind speed in kilometers per hour from step 1 by the weighting factor in hours from step 2. A worksheet showing step 3 is given below:

Wind layer (10³ m)	*Wind speed (km/hr) (step 1)* ×	*Weighting factor (hr) (step 2)* =	*Vector length (km)**	*Wind direction to (tens of mils)*
0–3	18	.97	17	440
3–6	18	.81	15	430
6–9	25	.75	19	420
9–12	29	.67	19	400
12–15	36	.63	23	380
15–20	36	.99	36	370
20–25	43	.90	39	370
25–30	29	.88	26	360

* Round distances off to nearest kilometer.

(4) *Step 4.* Prepare the wind vector plot. The procedure in this case will be exactly parallel to the procedure of example problem 3, steps 2 through 4, since all terms are in the same dimensions.

8. EXAMPLE PROBLEM 8. PREPARATION OF THE DETAILED FALLOUT PREDICTION

a. Situation. Assume that the wind vector plot of example problem 3 is available as of 070030Z. Before the next upper air wind data are received, a series of nuclear burst reports arrive at the CBRE.

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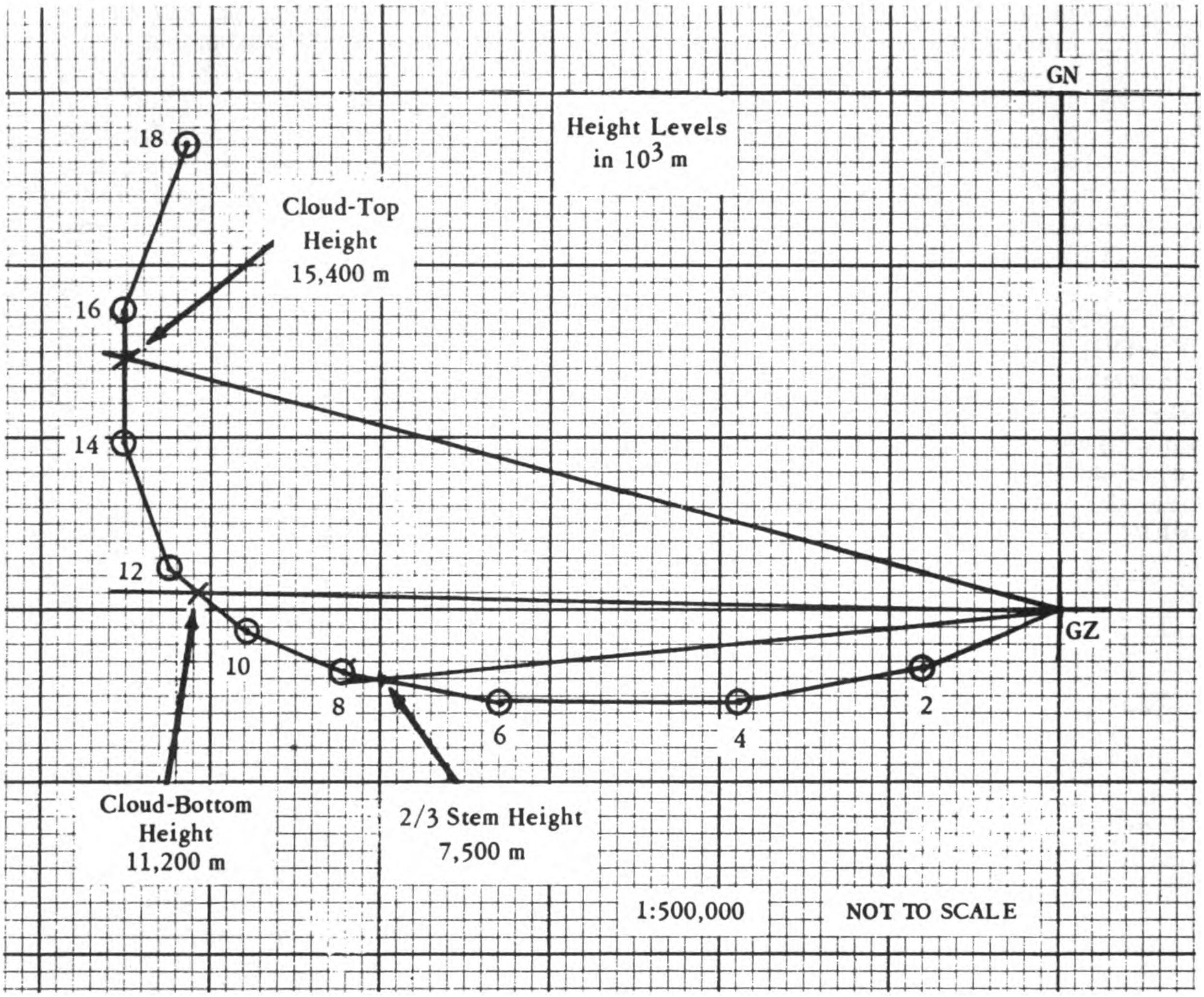


Figure 14. (1) *Example problem 8.*

These reports and other information indicate that a surface (fallout-producing) burst has occurred.

b. Action. Prepare a detailed fallout prediction, following the steps outlined in paragraph 25. The fallout wind vector plot has already been prepared to a map scale of 1:500,000 (example problem 3, (4, fig. 11)). Complete the detailed fallout prediction worksheet (fig. 6), using nuclear burst information provided and the values determined from the following steps:

(1) *Step 1.* Process the nuclear burst reports and establish the following nuclear burst information:

(*a*) Yield is estimated as 70 KT.

(*b*) The burst occurred at 070100Z at MN-345148.

(*c*) The burst was a surface burst.

(2) *Step 2.* Determine cloud parameters from figure 17. Place a straightedge horizontally across the figure until the values of the yield on the left yield index scale and right yield index scale are the same (70 KT). Read the cloud-top height (15,400 meters), cloud-bottom height (11,200 meters), two-thirds stem height (7,500 meters), time of fall from cloud bottom (3.05 hours), and cloud radius (5.1 kilometers).

(3) *Step 3.* Mark the points representing cloud-top height, cloud-bottom height, and two-thirds stem height on the fallout wind vector plot. Draw radial lines from GZ through these height points. Disregard vectors above the cloud-top height and below two-thirds stem height. Check to

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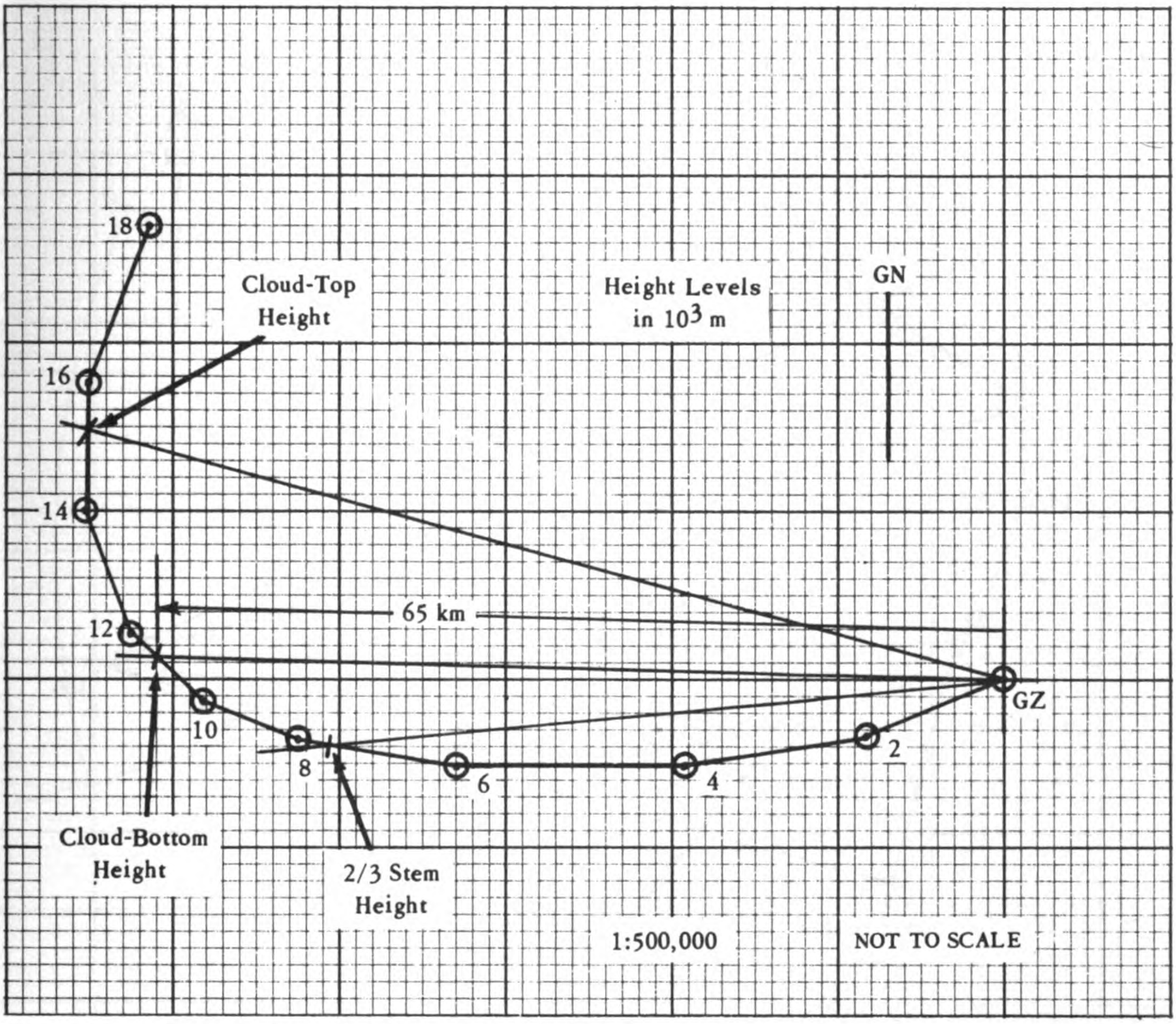


Figure 14 (2)—Continued.

see if any of the vectors *between* the cloud-top height and two-thirds stem height are outside these two radial lines. Since no vectors fall outside the radial lines, expansion of the radial lines is not necessary. Step 3 is shown in 1, figure 14.

(4) *Step 4.* Determine the effective wind speed. On the fallout wind vector plot, measure the length of the radial line from ground zero to cloud-bottom height in kilometers (2, fig. 14). In this case the distance is about 65 kilometers. Divide this distance by the time of fall from the cloud bottom.

$$\text{Effective wind speed} = \frac{\text{radial line distance from GZ to cloud-bottom height (km)}}{\text{time of fall from cloud bottom (hr)}}$$

$$= \frac{65\text{ km}}{3.05\text{ hr}} = 21.3\text{ km/hr} = 21\text{ km/hr*}$$

*Round off to nearest kilometer per hour.

(5) *Step 5.* Determine the downwind distances of Zones I and II.

(*a*) Use figure 18. Lay a straightedge from the yield on the lefthand scale to the value of the effective wind speed on the righthand scale; at the intersection of the straightedge with the center scale, read the downwind distance of the Zone of Immediate Operational Concern (Zone

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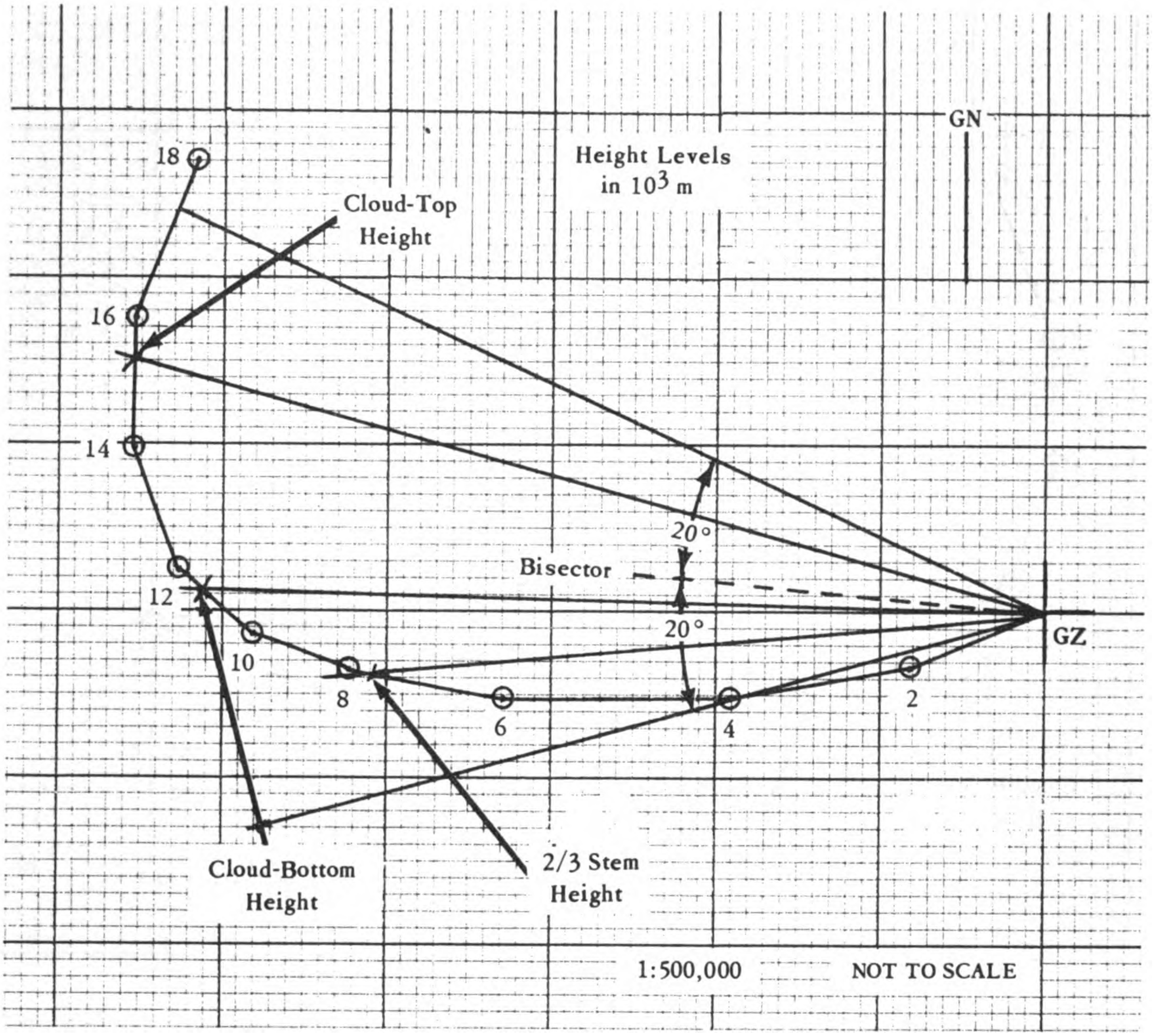


Figure 14 (3)—Continued.

I). In this case read approximately 30 kilometers. (Since this is a surface burst and fission yield to total yield ratio is not known, adjustment is not nccessary for the downwind distance; that is, HOB adjustment factor and FY/TY adjustment factor are both equal to 1.)

(*b*) Double this distance to determine the downwind distance of Zone II. 30 x 2 = 60 kilometeɪs.

(6) *Step 6.* Construct the final fallout prediction.

(*a*) Measure the angle formed by the radial lines drawn from GZ through the cloud-top height point and two-thirds stem height point. In this case the angle is about 21 degrees. Since this angle is less than 40 degrees, bisect the angle and draw lines from GZ, 20 degrees to the left and 20 degrees to the right of the bisector (3, fig. 14).

(*b*) On a sheet of overlay paper, mark grid north and trace the two radial lines ((*a*) above) at their proper azimuths. Extend these radial lines to convenient distances so that the final prediction

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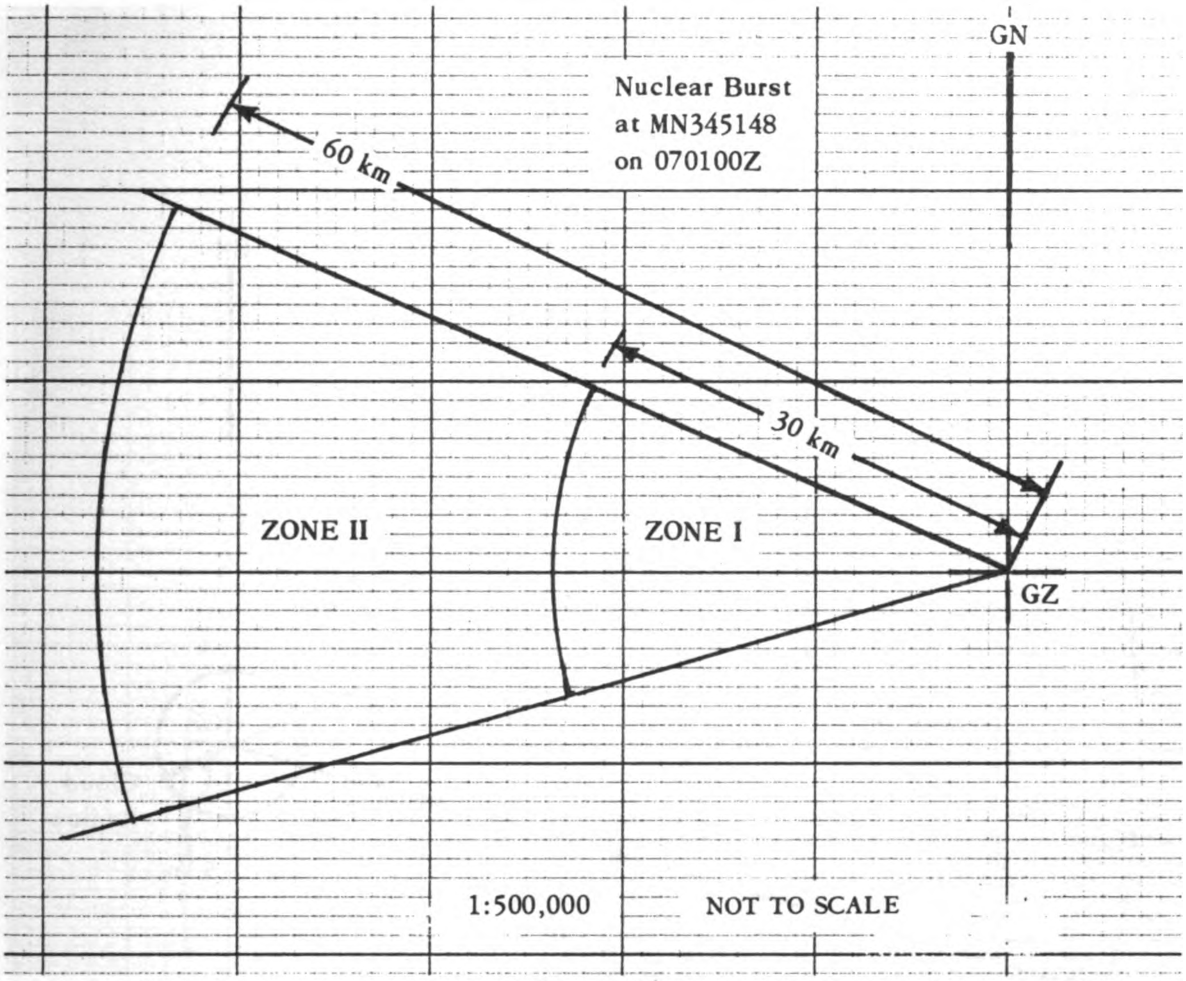


Figure 14 (4)—Continued.

can be made at the desired map scale. Between the extended radial lines drawn from GZ, and using GZ as center, draw two arcs at distances found in step 5 above (in this case 30 and 60 kilometers, respectively) (4, fig. 14).

(*c*) Draw a circle around GZ with a radius equal to the cloud radius (5.1 km) (5, fig. 14).

(*d*) Draw two tangents from the ground zero circle to the points of intersection of the two radial lines with the arc representing the downwind distance of Zone I (6, fig. 14).

(*e*) Indicate estimated times of arrival of fallout by drawing dashed arcs at distances equal to the product of the effective wind speed and the hour of interest; 21 kilometers for 1-hour time of arrival, 42 kilometers for 2-hour time of arrival, and 63 kilometers for 3-hour time of arrival (7, fig. 14).

(7) *Step 7.* Prepare the detailed fallout prediction message.

(*a*) Measure the azimuths of the left radial line at 254 degrees and the right radial line at 294 degrees.

(*b*) Prepare the fallout prediction message. (All figures which enter the HOTEL line of the fallout prediction message are rounded off to the nearest kilometer or kilometer per hour.)

Fallout Prediction Message

ZULU	070100
FOXTROT	MN345148
GOLF	254294
HOTEL	2103005

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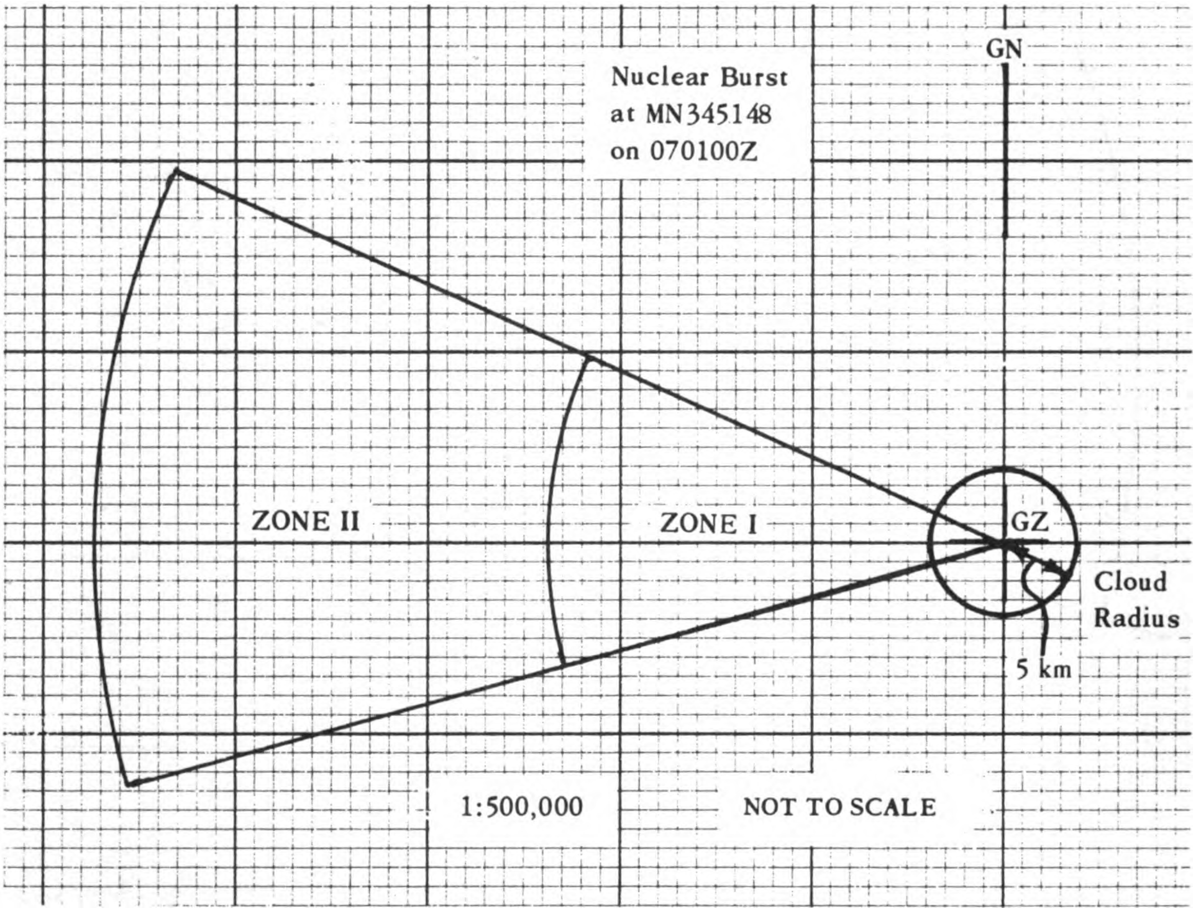


Figure 14 (5)—Continued.

(8) *Step 8.* Disseminate the fallout prediction message in accordance with SOP.

(9) *Step 9.* See figure 15 for a completed detailed fallout prediction worksheet.

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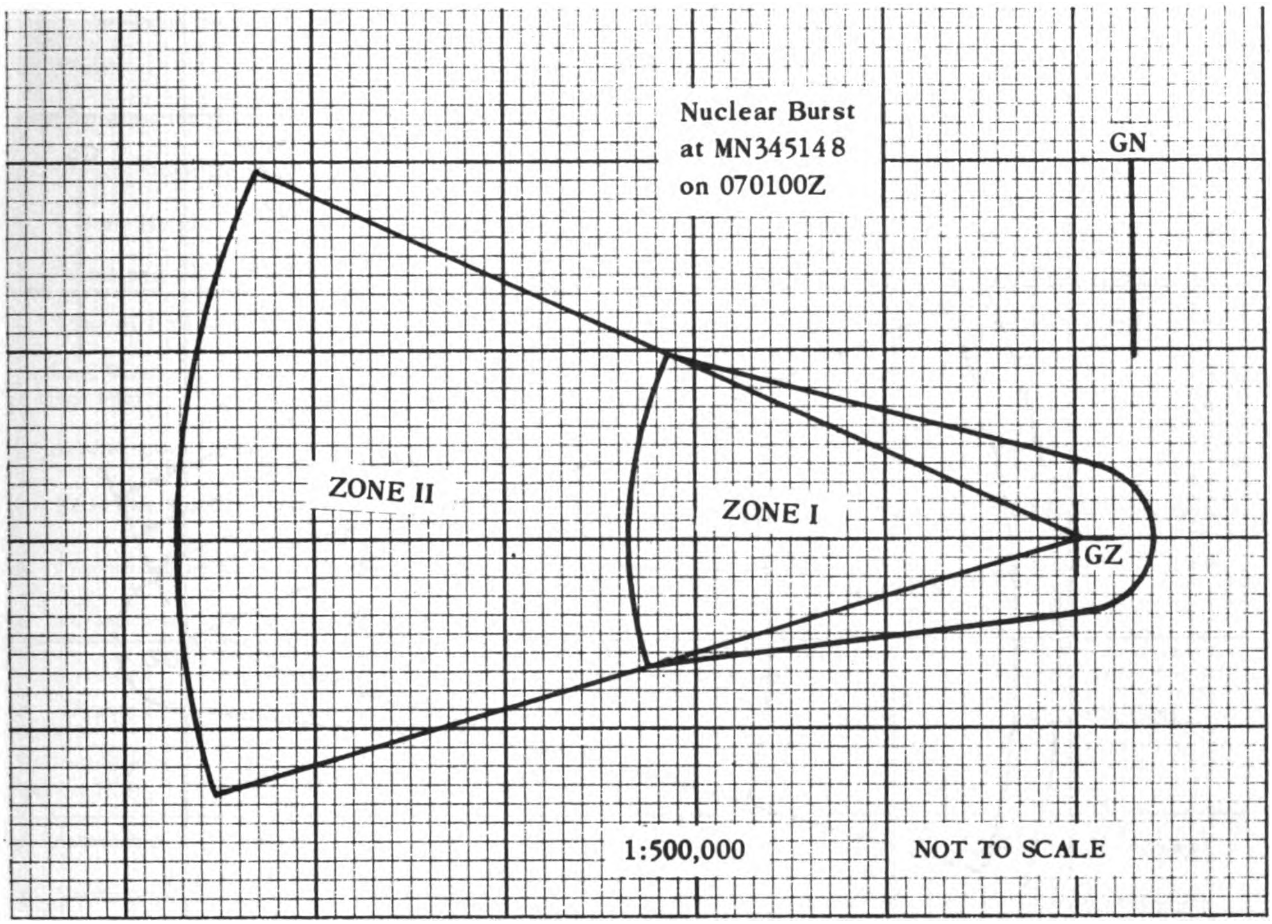


Figure 14 (6)—Continued.

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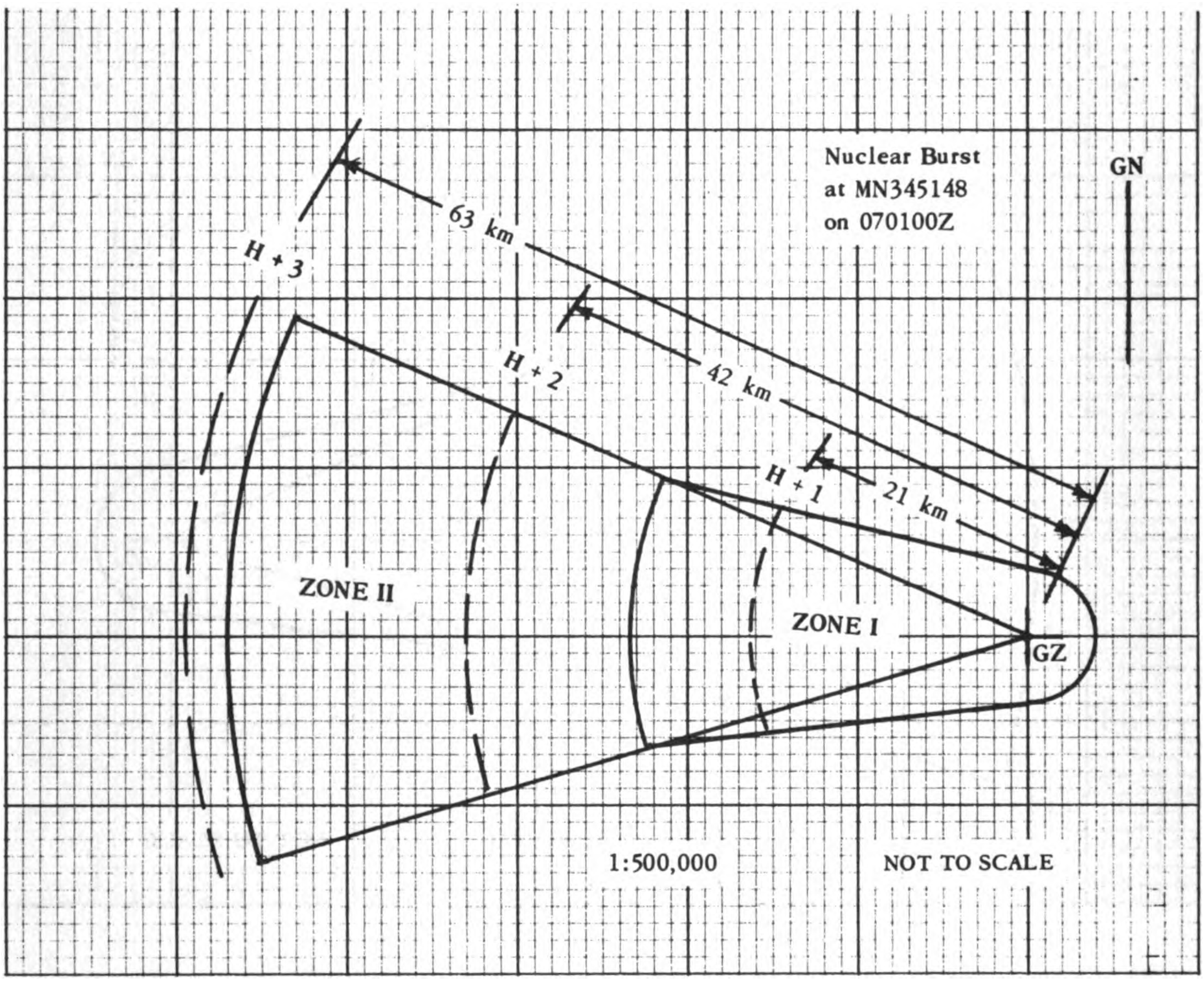


Figure 14 (7)—Continued.

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a. Time of Burst (date-time group)		070100	ZULU DDtttt
b. GZ Coordinates		MN345148	FOXTROT yyzzzzzz
c. FY/TY Ratio (from target analyst for friendly weapons only)		1	
d. HOB (from target analyst for friendly weapons only)		0	meters
e. Yield		70	KT ~~or MT~~
f. Cloud-top Height	(fig. 17)	15.4	10^3 meters ~~or feet~~
g. Cloud-bottom Height	(fig. 17)	11.2	10^3 meters ~~or feet~~
h. ⅔ Stem Height	(fig. 17)	7.5	10^3 meters ~~or feet~~
i. Stabilized Cloud Radius	(fig. 17)	5.1	HOTEL rr (km)
j. Time of Fall from Cloud Bottom	(fig. 17)	3.05	hours

Fallout Wind Vector Plot (Enter f, g, & h radial lines on wind vector plot and measure distance from GZ to cloud-bottom height.)

k. Radial Line Distance from GZ to Cloud-bottom Height	65	km

l. Effective Wind Speed = $\frac{k \text{ (GZ-CB dist)}}{j \text{ (Time of fall)}} = \frac{65}{3.05} \frac{\text{km}}{\text{hr}} = 21$ HOTEL ss (km/hr)

m. Downwind Distance of Zone I (Enter fig. 18 with l and e.) 30 km

n. Adjustment = FY/TY Factor 1 (Enter fig. 21 with e and c or use one.) × HOB Factor 1 (Enter fig. 19 or 20 with d and e or use one.) = 1

o. Adjusted Downwind Distance of Zone I (m × n) 30 HOTEL xxx (km)

Fallout Wind Vector Plot (Check lateral limits for 40 degrees.)

p. Azimuth of Left Radial Line	254	GOLF ddd (degrees)
q. Azimuth of Right Radial Line	294	GOLF ccc (degrees)

r. Fallout Prediction Message:

ZULU	DDtttt	0	7	0	1	0	0			(date-time group)
FOXTROT	yyzzzzzz	M	N	3	4	5	1	4	8	(GZ coordinates)
GOLF	dddccc	2	5	4	2	9	4			(azimuths of radial lines)
HOTEL	ssxxxrr	2	1	0	3	0	0	5		
		(effective wind speed)		(downwind distance)			(cloud radius)			

Figure 15. Detailed fallout prediction worksheet (completed).

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APPENDIX III

TABLES AND FIGURES USED FOR FALLOUT PREDICTION

Tables and figures included in this appendix are referenced in the body of the manual or in appendix II as their purpose is established. These tables and figures are grouped for the convenience of the user.

Table I. Mils to Degrees Conversion Table

Mils	Degrees	Mils	Degrees
0	0	3,300	186
100	6	3,400	191
200	11	3,500	197
300	17	3,600	203
400	23	3,700	208
500	28	3,800	214
600	34	3,900	220
700	40	4,000	225
800	45	4,100	231
900	51	4,200	237
1,000	57	4,300	242
1,100	62	4,400	247
1,200	67	4,500	253
1,300	73	4,600	259
1,400	79	4,700	264
1,500	84	4,800	270
1,600	90	4,900	276
1,700	96	5,000	281
1,800	101	5,100	287
1,900	107	5,200	293
2,000	113	5,300	298
2,100	118	5,400	304
2,200	124	5,500	310
2,300	130	5,600	315
2,400	135	5,700	321
2,500	141	5,800	327
2,600	147	5,900	332
2,700	152	6,000	337
2,800	157	6,100	343
2,900	163	6,200	349
3,000	169	6,300	354
3,100	174	6,400	360
3,200	180		

*Table II. Distance Conversion Table**

To convert—	To—	Multiply by—
kilometers	miles	0.62
kilometers	nautical miles	0.54
miles	kilometers	1.61
miles	nautical miles	0.87
nautical miles	kilometers	1.85
nautical miles	miles	1.15

* The same conversion factors are used when changing one velocity to another in a different units system.

Note that 1 knot is equal to 1 nautical mile per hour.

Table III. Weighting Factors for 2,000-Meter Wind Layers (to be used with US Army artillery wind data)

Wind layer (10^2 meters)	Time in layer (hours)	Weighting factor (multiply wind speed in knots by this factor to get kilometers)
0–2	.68	1.26
2–4	.59	1.09
4–6	.52	.96
6–8	.50	.93
8–10	.48	.89
10–12	.45	.83
12–14	.42	.78
14–16	.40	.74
16–18	.39	.72
18–20	.38	.70
20–22	.37	.69
22–24	.36	.67
24–26	.36	.67
26–28	.35	.65
28–30	.34	.63

Table IV. Weighting Factors and Plotting Scale Data for 5,000-Foot Wind Layers (to be used with Air Weather Service wind data)

Wind layer 10^3 feet)	Time in layer (hours)	Weighting factor (multiply wind speed in knots by this factor to get kilometers)	Plotting scale slot (to be used with the wind layer that is indicated)	Adjustment factor (multiply reported wind speed by this factor before plotting)
0–5	.51	.94	6–8	1
5–10	.46	.85	10–12	1
10–15	.43	.80	12–14	1
15–20	.41	.76	14–16	1
20–25	.39	.72	16–18	1
25–30	.37	.68	20–22	1
30–35	.35	.65	26–28	1
35–40	.34	.62	28–30	1
40–45	.32	.59	28–30	1
45–50	.31	.57	2–4	one-half
50–55	.30	.56	2–4	one-half
55–60	.30	.56	2–4	one-half
60–65	.29	.54	2–4	one-half
65–70	.28	.52	2–4	one-half
70–75	.28	.52	2–4	one-half
75–80	.27	.50	4–6	one-half
80–85	.27	.50	4–6	one-half
85–90	.27	.50	4–6	one-half
90–95	.27	.50	4–6	one-half
95–100	.26	.48	4–6	one-half

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Table V: Weighting Factors and Plotting Scale Data (to be used with Air Weather Service constant pressure surface winds)

Constant pressure surface (Millibars)	Wind layer (10^3 feet)	Weighting factor (multiply wind speed in knots by this factor to get kilometers)	Plotting scale slot (to be used with the wind layer that is indicated)	Adjustment factor (multiply reported wind speed by this factor before plotting)
850	0–5	.95	4–6	1
700	5–10	.85	10–12	1
500	10–18	1.26	0–2	1
300	18–30	1.71	8–10	2
100	30–53	2.79	18–20	4

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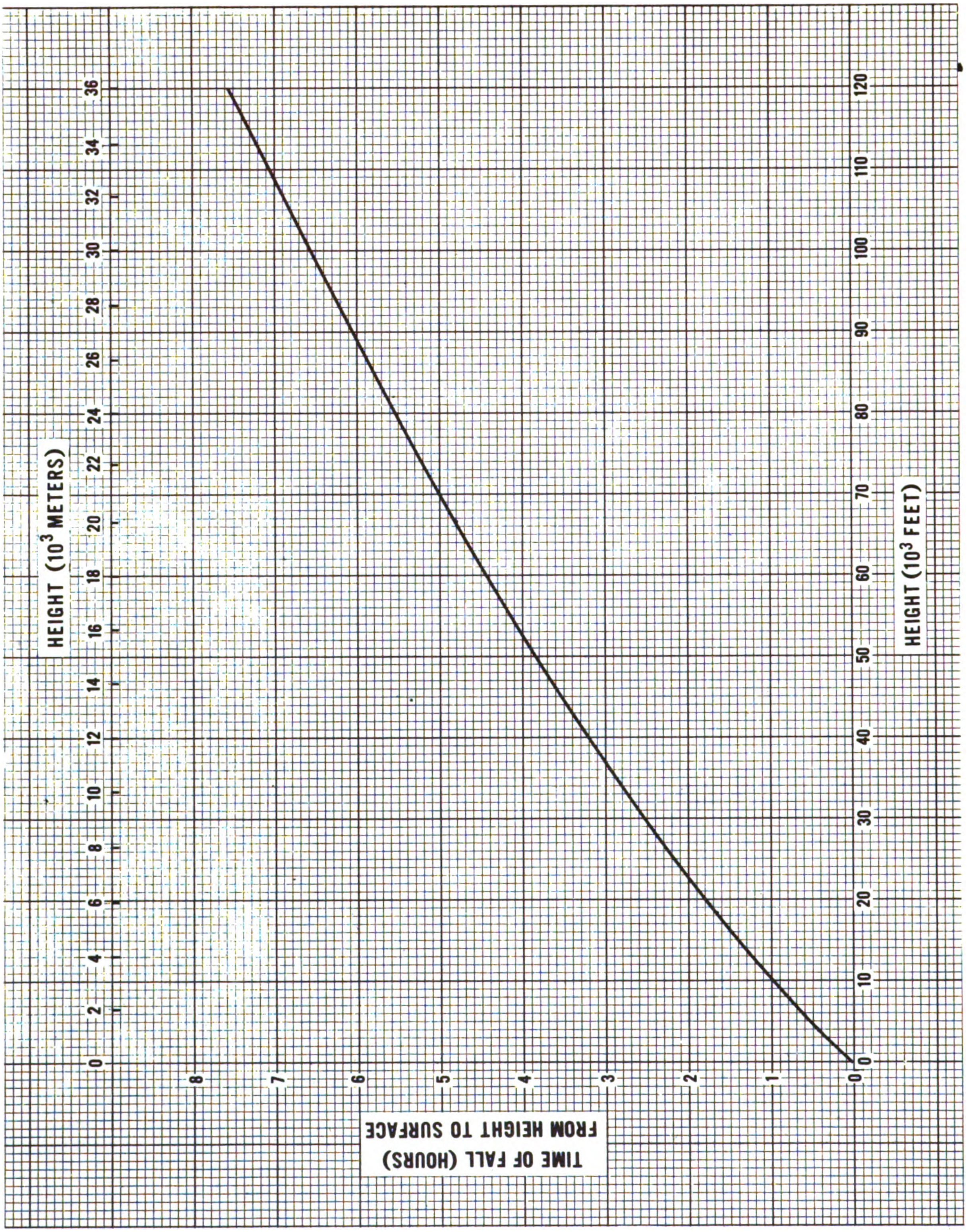


Figure 16. Time of fall (nominal size particle).

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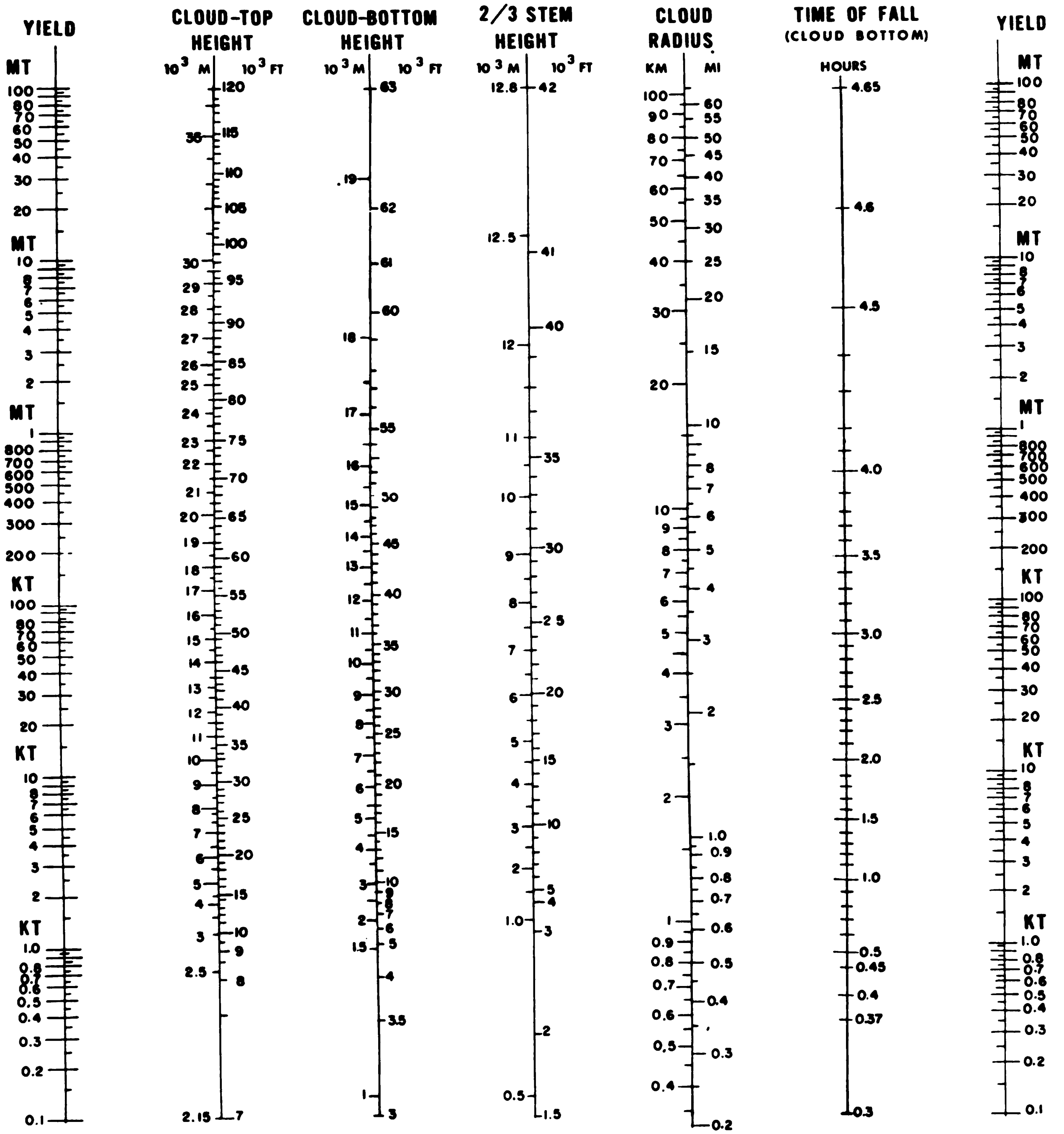


Figure 17. Radioactive cloud and stem parameters.

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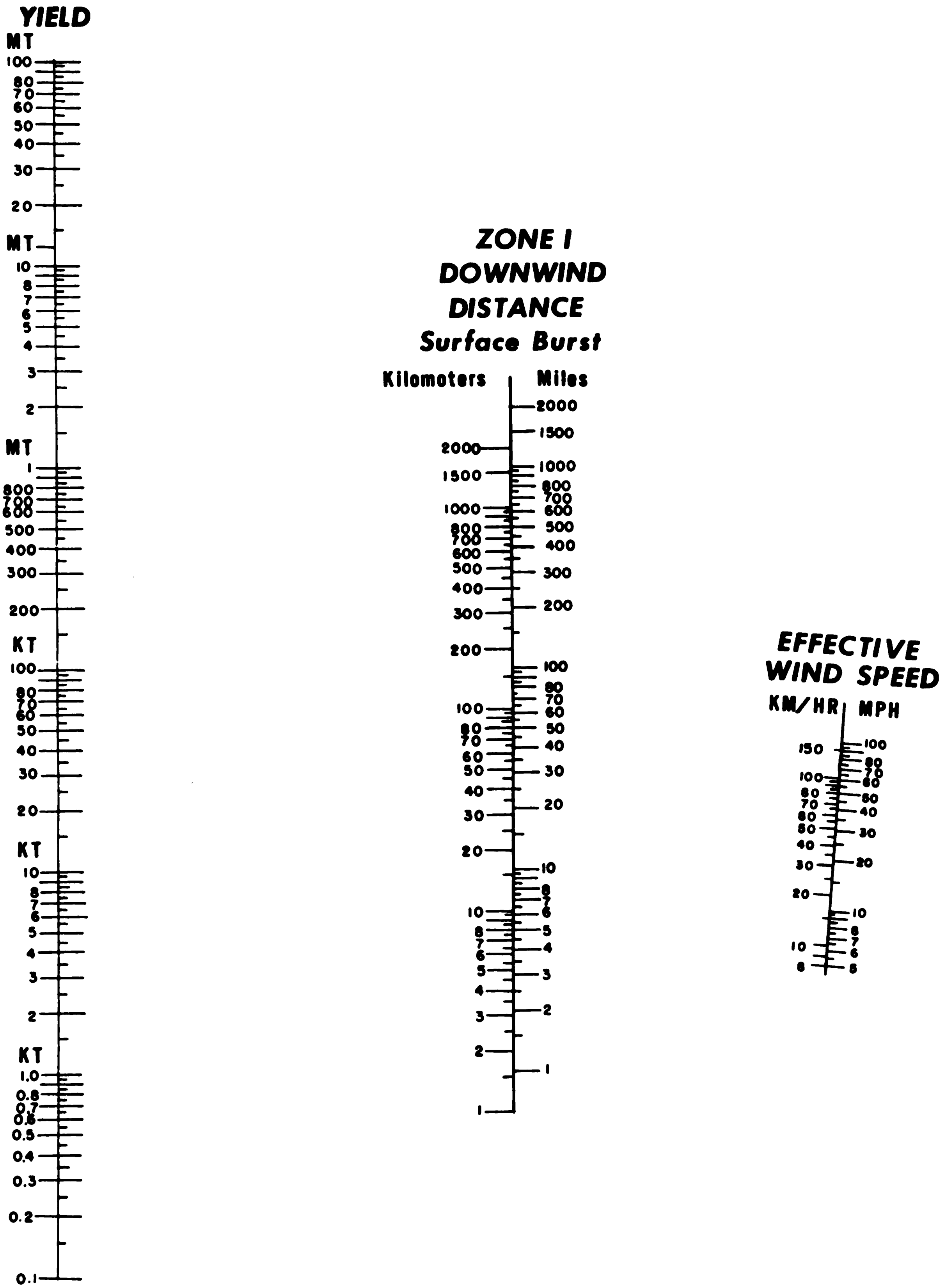


Figure 18. Zone I downwind distance, surface burst.

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Yield ≤ 100 KT

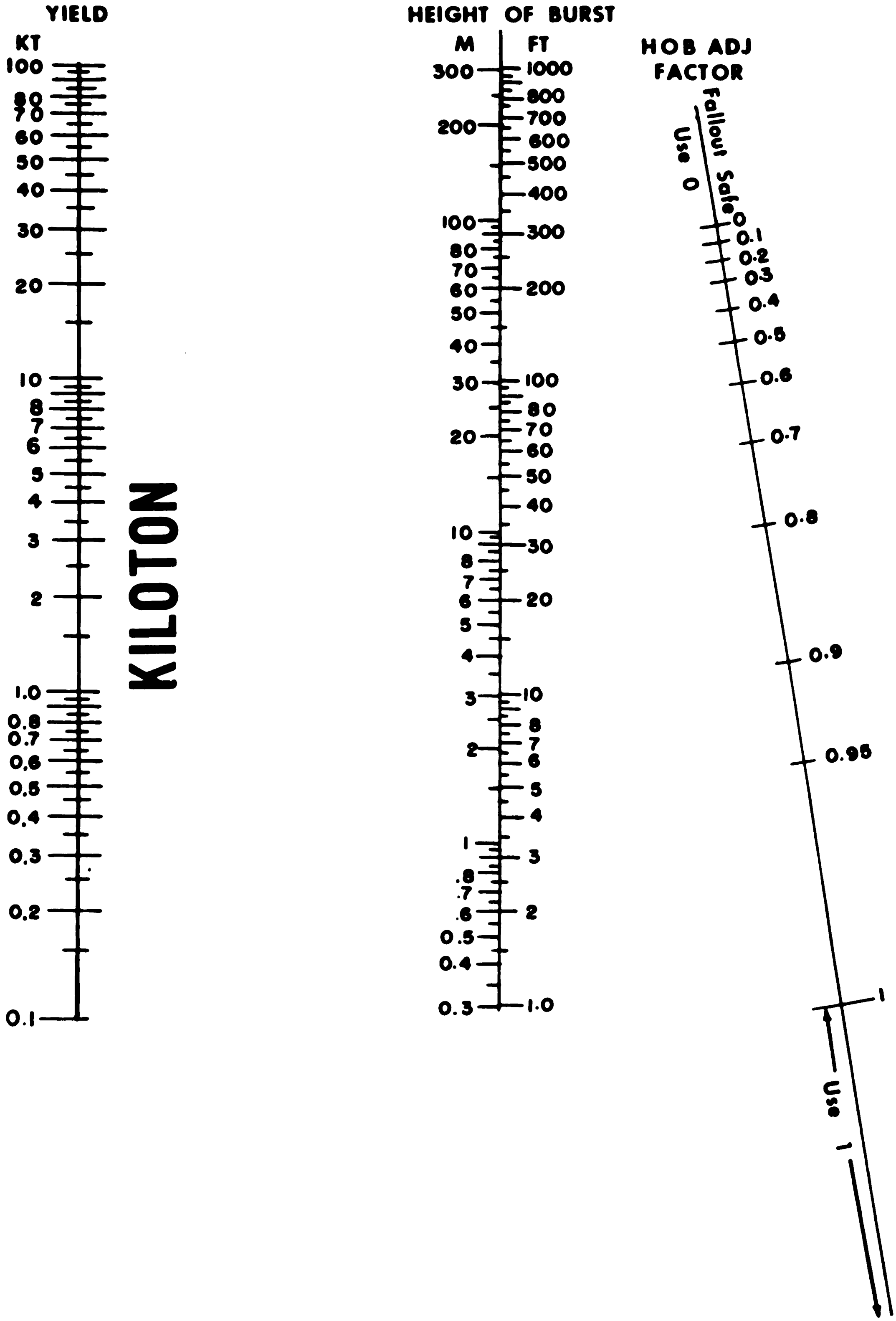


Figure 19. Height of burst adjustment factor, kiloton.

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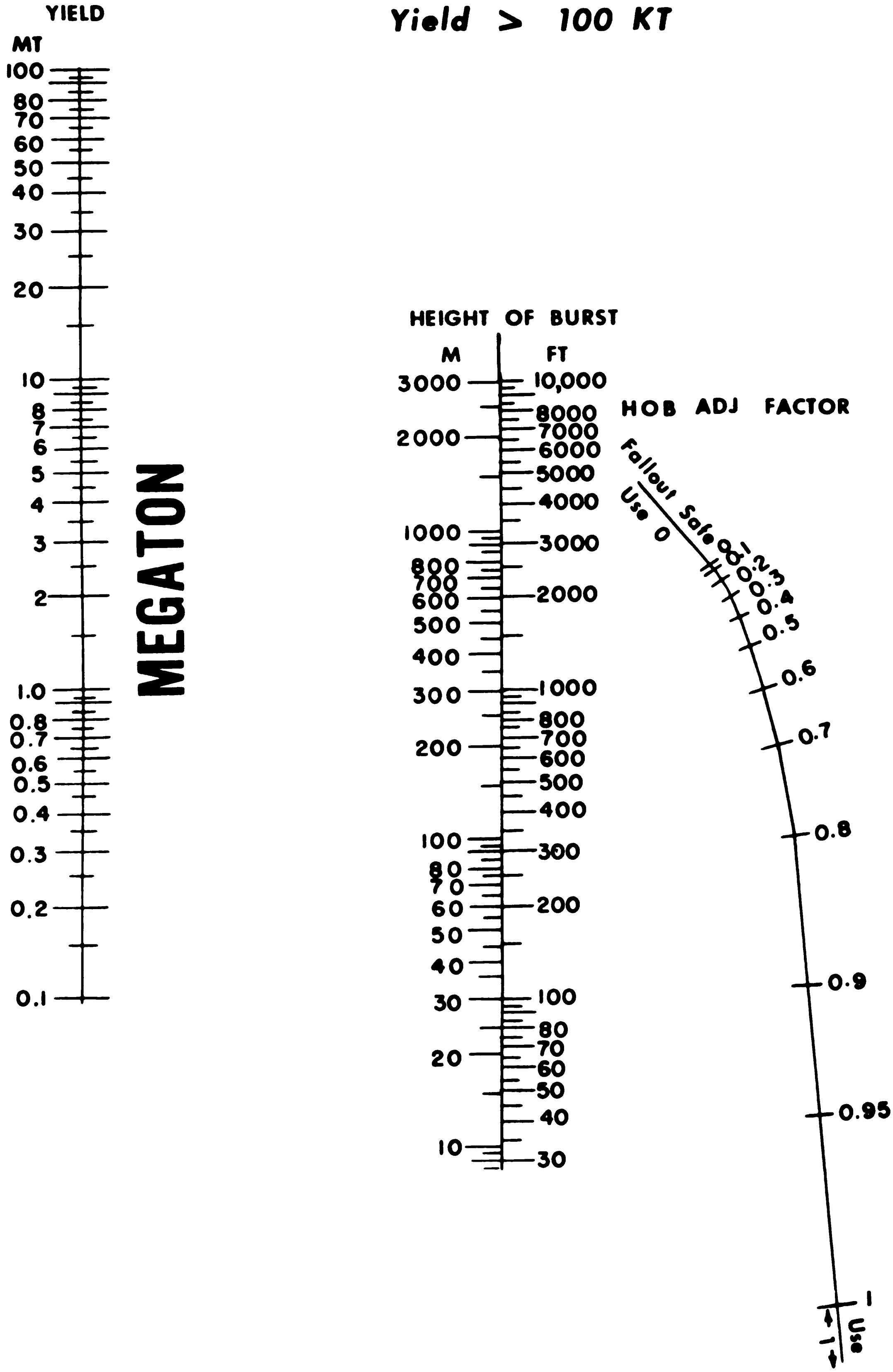


Figure 20. Height of burst adjustment factor, megaton.

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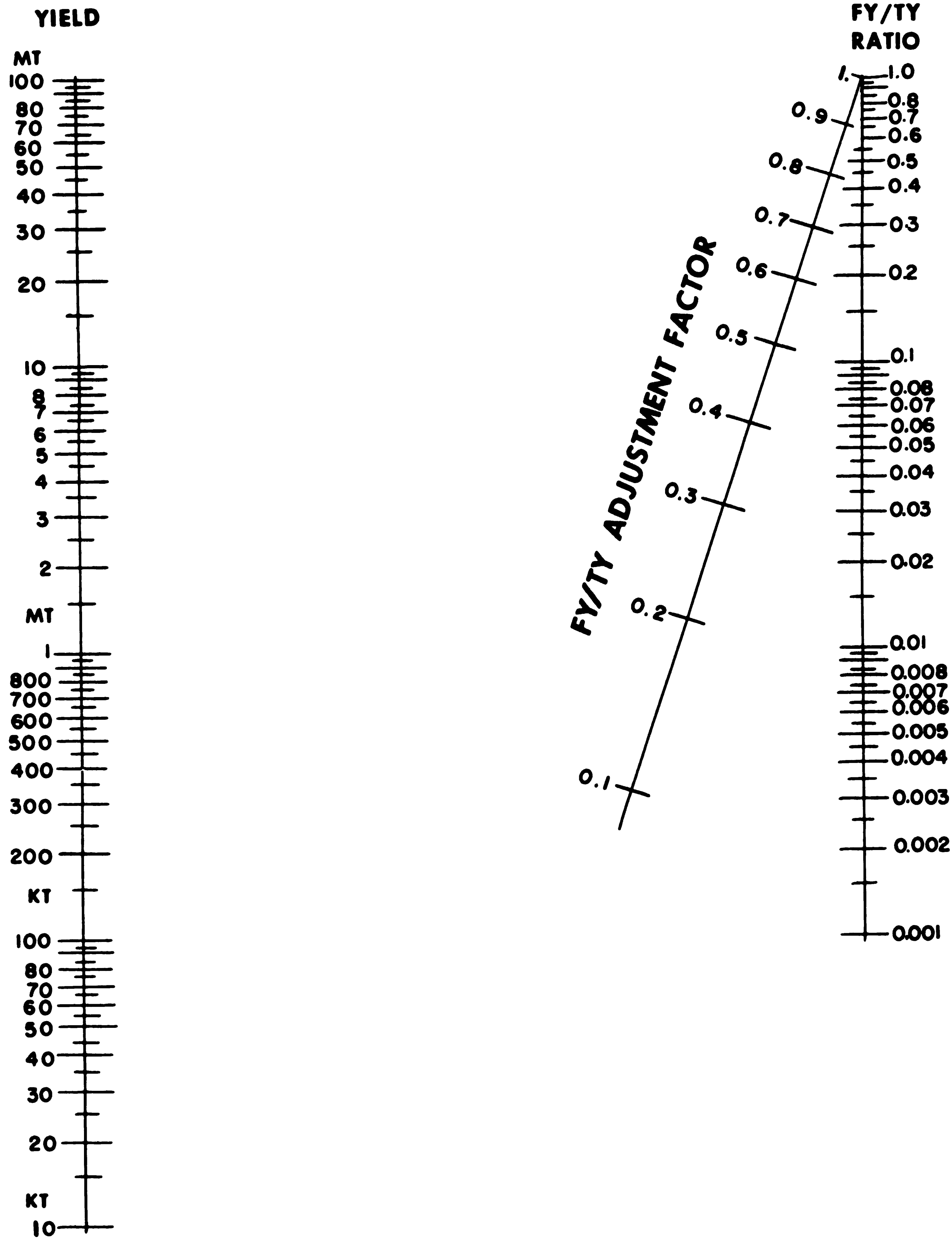


Figure 21. Fission yield/total yield adjustment factor.

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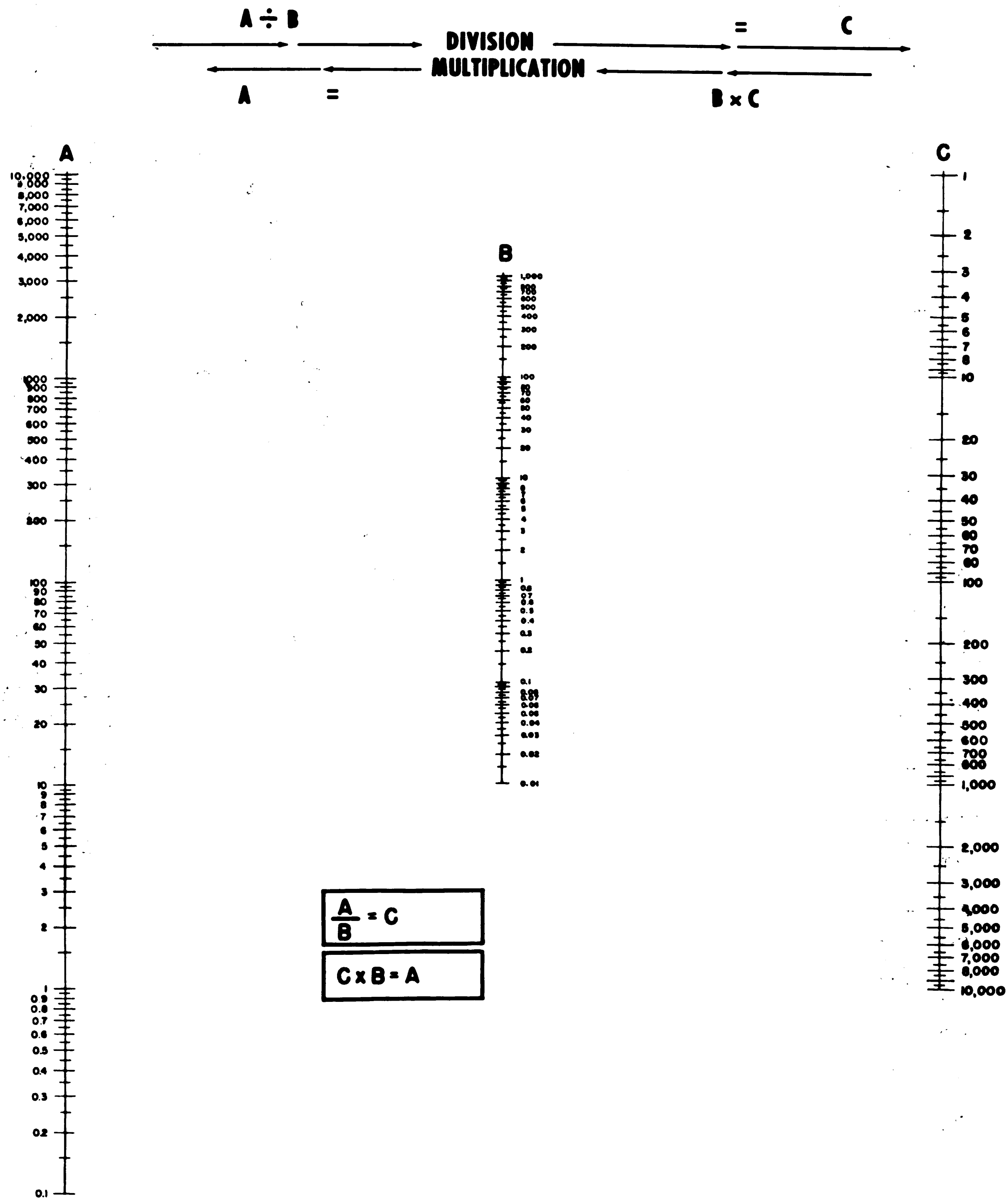


Figure 22. Multiplication-division nomogram.

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Instl (2)
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  3-7 (14)
  3-500 JA, LA (5)

NG: State AG (3) Corps Arty, Div, Div Arty, Bde, Regt/Gp/BG, Bn (1) except Armd Div (4) (1 each CC).
USAR: Same as active Army except allowance is one copy to each unit.
For explanation of abbreviations used, see AR 320-50.

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